The Proceedings of the Geophysical Society of Tulsa

JOSEPH A. SHARPE
Memorial Volume

TABLE OF CONTENTS — PAGE 19

Volume I **1953**


EXPERIENCE • ECONOMY • PERFORMANCE
YES! CONSOLIDATED
.... BECAUSE TRULY
GOOD GRAVITY MAPPING
PAYS BIG DIVIDENDS
PHOTO GRAVITY MAPPING
C. D. ROEMER
GEOLOGY
EXPLORATION ENGINEERS
JAMES R. NEW
GEOPHYSICS
CONSOLIDATED GEOPHYSICAL SURVEYS
BOULDER BUILDING
TULSA, OKLAHOMA

THE GEOPHYSICAL SOCIETY OF TULSA

Founded 1947

Officers 1953 - 1954

President	Norman H. Ricker
First Vice-President	John M. Crawford
Second Vice-President	R. W. Mossman
Secretary	Tom F. Southgate
Treasurer	David R. Weichert

☆

DISTRICT REPRESENTATIVES TO THE S. E. G.

E. V. McCollum

R. H. Tucker

R. G. Piety

☆

PROGRAM COMMITTEE

John M. Crawford, *Chairman*

L. Y. Faust	W. B. Robinson
J. E. Hawkins	J. C. Rollins
R. G. Piety	R. A. Weingartner

☆

Editor of the Proceedings of the Geophysical Society of Tulsa	Robert J. Watson
Business Manager	Fielding L. Mitchell

HISTORY OF THE GEOPHYSICAL SOCIETY OF TULSA

The Geophysical Society of Tulsa was the first of the local sections of the Society of Exploration Geophysicists to be organized. The organization took place February 4, 1947, at a meeting attended by sixty local members of the S. E. G. and guests. The temporary officers elected were:

President	R. Clare Coffin
Vice-President	E. Jack Handley
Secretary	Colin C. Campbell

The first regular monthly meeting and technical session was held March 13, 1947, in the Student Union of the University of Tulsa. The original Constitution and bylaws were drafted by V. L. Jones, Stanley W. Wilcox, and the temporary officers. The charter members were signed, bringing the total membership to 130. The temporary officers served until the May 1947 meeting.

The proposal to publish this Memorial Volume and the appointment of the Editor were made by Paul L. Lyons while President during the period 1952-1953.

OFFICERS OF THE GEOPHYSICAL SOCIETY OF TULSA

1947-48

President	R. Clare Coffin
First Vice-President	A. B. Bryan
Second Vice-President	H. M. Thralls
Secretary-Treasurer	Francis F. Campbell
Members of the Executive Committee	J. A. Sharpe and E. J. Handley

DISTRICT REPRESENTATIVES TO THE S. E. G.

R. W. Gemmer
J. P. Garner
W. H. Courtier

1948-49

President	A. B. Bryan
First Vice-President	Francis F. Campbell
Second Vice-President	V. L. Jones
Secretary-Treasurer	Glen D. Lambert

DISTRICT REPRESENTATIVES TO THE S. E. G.

J. P. Garner
W. H. Courtier

1949-50

President	W. T. Born
First Vice-President	E. M. McNatt
Second Vice-President	N. J. Christie
Secretary-Treasurer	N. R. Sparks

DISTRICT REPRESENTATIVES TO THE S. E. G.

J. P. Garner
J. E. Hawkins

1950-51

President	H. M. Thralls
First Vice-President	Paul L. Lyons
Second Vice-President	Neal Clayton
Secretary	Robert C. Kendall
Treasurer	Wm. M. Erdahl

DISTRICT REPRESENTATIVE TO THE S. E. G.

John M. Crawford

1951-52

President	R. W. Gemmer
First Vice-President	Craig Ferris
Second Vice-President	J. E. Hawkins
Secretary	J. C. Rollins
Treasurer	Clare N. Hurry

DISTRICT REPRESENTATIVES TO THE S. E. G.

R. H. Tucker
R. G. Piety
John Crawford

1952-53

President	Paul L. Lyons
First Vice-President	L. Y. Faust
Second Vice-President	W. B. Agocs
Secretary	Dallas R. Davis
Treasurer	Francis H. Cady

DISTRICT REPRESENTATIVES TO THE S. E. G.

E. V. McCollum
Reese H. Tucker
R. G. Piety

GEOPHYSICAL SOCIETY OF TULSA

CHARTER MEMBERS

Karl W. Abel
Warren A. Alexander
John F. Anderson
A. J. Barthelmes
Thomas J. Bevan
F. L. Bishop
F. W. Borman
F. G. Boucher
Duncan M. Bowie
D. C. Bowman
Ross E. Brannian
H. W. Brown
C. L. Brownlow
A. B. Bryan
C. E. Buffum
Colin C. Campbell
Francis F. Campbell
Frank L. Campbell
Tun Yin Chang
Norman J. Christie
R. F. Christy
Lawson Clary, Jr.
A. F. Cline
R. Clare Coffin
E. H. Cooley
Jack R. Cooper
Jack M. Copass
W. H. Courtier
Robert L. Craig
C. C. Crenshaw
W. W. Crump
W. J. Cunningham
Dallas R. Davis
Thomas L. Davis
Charles J. Deegan
Opie Dimmick
Karl Dyk
George J. Dzwons
Carl L. Edmondson
J. D. Eiseler
W. M. Erdahl
J. F. Evans
L. Y. Faust
John L. Ferguson
Craig Ferris
Robert S. Finn
G. A. Foster
J. P. Garner
Erik U. Garpner
R. W. Gemmer
C. D. Gibson
Andrew Gilmour
Charles F. Hadley
E. Jack Handley
Bruce H. Harlton
Ralph E. Hartline
Jean W. Heim
C. E. Hendricks
Haines C. Hibbard
C. D. Hier
Robert J. Hodges
R. B. Hollingsworth
A. Maxwell House
C. R. Humphrey
Clare Hurry
A. I. Innes
Judson G. Jackson
Glendon D. Jett
John Paul Jones
V. L. Jones
John K. Kenton
J. L. Kezeler
S. A. LaGreca
John Lahmeyer
G. D. Lambert
W. W. Lamkin
H. M. Lang
Charles C. Lash
J. Austin Lawless
C. C. Ludwick
Ralph D. Lynn
Paul L. Lyons
R. L. Mathieson
Tom D. Mayes
C. E. McClure
E. V. McCollum
E. M. McNatt
J. W. Miller
Homer C. Moore
L. E. Moore
W. Lee Moore
Lawrence K. Morris
M. E. Morrow
Helenita Officer
H. E. Owen
B. G. Preston
William E. Pugh
W. J. Robinson
David E. Reed
R. S. Reed
R. B. Rice
Norman Ricker
J. C. Rollins
Marvin Romberg
John W. Ross
Ralph B. Ross
J. J. Rupnick
Joseph A. Sharpe
Jimmie E. Skinner
G. N. Smith
Neil R. Sparks
T. V. Stephens
Thomas C. Stotler
Edward B. Stover, Jr.
W. R. Sype
T. J. Thomas
Delbert C. Thomas
H. M. Thralls
R. H. Tucker
Stefan Von Croy
W. Day Waldrep
J. I. Walton
Dwight E. Ward
David R. Weichert
R. A. Weingartner
M. B. Widess
Stanley W. Wilcox
P. S. Williams
N. H. Williamson
Earl M. Wolters

CONSTITUTION AND BY-LAWS

(As amended to November 13, 1952)

ARTICLE I

NAME

The name of this Society is the *Geophysical Society of Tulsa.* It shall be the Tulsa Section of the Society of Exploration Geophysicists.

ARTICLE II

OBJECT

The object of this Society is to promote the science of geophysics especially as it applies to exploration, and to promote fellowship and cooperation among those persons interested in geophysical problems.

ARTICLE III

MEMBERSHIP

1. Any person interested in the geophysical profession shall be eligible for membership.
2. Applications for membership shall be submitted in writing, and shall be signed by three sponsors who are members of the Society.
3. Applications shall be approved for membership by the Executive Committee.
4. The annual dues of members of the Society shall be three dollars ($3.00) payable in advance on the first day of each calendar year.
5. Members whose applications are approved after July 1 shall be required to pay only one-half the regular annual dues for the remainder of the first year o ftheir membership.
6. Charter Members of this Society will be those who attended the first organizational meeting of the Society on February 4, 1947, or who attended the second meeting on March 13, 1947, and signed the respective roll as charter members, and who have paid dues for the year 1947.

ARTICLE IV

RESIGNATION AND SUSPENSION

1. Any member may resign from the Society at any time. Such Resignation shall be in writing and shall be accepted by the Executive Committee, subject to the payment of all outstanding dues and obligations of the resigning member.
2. Any member who is more than one year delinquent in payment of dues shall be suspended from the Society. Any delinquent or suspended member, at his own option, may request in writing that he be dropped from the Society and such request shall be granted by the Executive Committee after due notification. Any member more than two years in arrears shall be dropped from the Society.

Note: The Constitution was originally adopted March 13, 1947. It was amended January 8, 1948, November 11, 1948, February 9, 1950, and November 13, 1952. The By-laws were amended February 9, 1950, and November 13, 1952. The editor is very much indebted to Paul L. Lyons for his assistance in writing and editing this revision of the Constitution.

3. Any person who has ceased to be a member under Section 1 or Section 2 of this Article may be reinstated by unanimous vote of the Executive Committee subject to the payment of any outstanding dues and obligations which were incurred prior to the date when he ceased to be a member of the Society.

ARTICLE V
OFFICERS AND THEIR DUTIES

1. The officers of the Society shall be: President, First Vice-President, Second Vice President, Secretary, Treasurer, and Editor.
2. There shall be district representatives to the Society of Exploration Geophysicists, as provided in the constitution of that society.
3. The Executive Committee shall consist of the Officers, the two most recent available past presidents, and the district representative, or representatives, to the Society of Exploration Geophysicists.
4. The Officers shall be elected by a ballot as hereinafter provided at the Annual Meeting, and shall hold office for one year.
5. The President shall preside at the meetings of the Society and of the Executive Committee. He shall call special meetings when deemed advisable; shall appoint all committees except as otherwise herein provided; and, jointly with the Secretary-Treasurer, shall sign all written contracts and other obligations of the Society. In the temporary absence of other Officers, he shall assume their duties or delegate them.
6. The First Vice-President shall be responsible for arranging the technical program of the Society, and shall have authority to appoint such assistants as he may require. He shall perfor mthe duties of President in the absence or disability of that Officer, and in case of the President's resignation shall become President for the remainder of the term.
7. The Second Vice-President shall be responsible for arranging entertainment, and shall have power to appoint members to assist him.
8. The Secretary shall maintain a complete list of the membership of the Society and of its Executive Committee, shall mail advance notice of meetings to all members, shall keep minutes of meetings of the Society, and of its Executive Committee, shall notify the members by mail of proposed amendments to the Constitution, and shall mail and receive ballots.

   The Secretary shall submit to the Secretary-Treasurer of the Society of Exploration Geophysicists a report of each meeting of this Society and of its Executive Committee within two weeks following each such meeting. He shall also submit to the Secretary-Treasurer of the Society of Exploration Geophysicists the names of all Officers and Committee members within two weeks after their election or appointment.
9. The Treasurer shall collect all dues and other obligations to the Society, shall make disbursements authorized by the Executive Committee and shall transact such other business as may be authorized by the Executive Committee. He shall maintain a chronological record of all receipts and expenditures as well as a system of records ex-

plaining each expenditure, including evidence of authority to expend funds and evidence of payment. He shall report the condition of the Treasury at each Annual Meeting and at other times upon request of the Executive Committee.

When so instructed by the Executive Committee, he shall make application to the Secretary-Treasurer of the Society of Exploration Geophysicists for such portion of the expenses to be borne by that Society, as may be needed, and shall submit to the Secretary-Treasurer of the Society of Exploration Geophysicists, prior to the annual meeting of that Society, an itemized account of the expenditure of such funds as may have been received from the Society of Exploration Geophysicists during the preceding calendar year.

A quorum of the Executive Committee shall consist of at least four members and approval by at least four members will be necessary to conduct all business of the Society.

10. The Editor shall be in charge of the editorial business, shall submit an annual report of such business, shall have authority to solicit papers and material for the regular society publication and for special publications, and may accept or reject material offered for publication. He may appoint editorial assistants.
11. The Executive Committee shall transact all business of the Society not otherwise herein specifically provided for. It shall elect all members to the Society, shall authorize all expenditures, shall direct investments of Society funds, shall establish and supervise publications; shall approve and recommend all proposals for special assessments; shall fill vacancies occurring in any office except in the office of President, to which the First Vice-President automatically succeeds, and shall have the power to review all actions and appointments by the Officers.
12. The District Representatives of the Society of Exploration Geophysicists shall represent the Society and its members at meetings of the Council of the Society of Exploration Geophysicists.

ARTICLE VI

ELECTION OF OFFICERS

1. A slate of nominations for officers shall be prepared by a Committee of Nominations consisting of the President and the two most recent available Past Presidents. They must secure the consent of all candidates nominated. This slate, of two or more candidates for each office, shall be prepared and announced to the Society at its regular meeting in March of each year.

Additional nominations for each office may be made by written petition of ten or more members in good standing. Such nominations must be submitted to the President not later than the close of the regular meeting in April.

The election of officers shall be by secret mail ballot. The Secretary shall mail to all members, not later than three weeks preceding the Annual Meeting, a ballot listing all candidates properly nominated

for each office. Each member voting shall cast one vote for each officer and shall return his ballot to the Secretary in a sealed envelope carrying on the outside his written signature. Only ballots so prepared by members in good standing and received by the secretary by 4 P.M. on the Monday immediately preceding the Annual Meeting shall be valid.

The Secretary shall indicate which ballots are valid and shall deliver them unopened to the Committee on Nominations. The Committee on Nominations shall supervise the counting of ballots prior to the Annual Meeting. The candidates receiving the greatest number of votes cast for an office shall be declared elected to that office. In case of a tie, the Executive Committee shall decide which of the tied candidates shall be elected.

2. The Committee on Nominations shall prepare a slate of nominations for any posts of district representatives to the Society of Exploration Geophysicists, which may need to be filled. Additional nominations may be made in the manner set forth in Section 1. The election shall be by secret ballot at least three weeks prior to the annual meeting of the Society of Exploration Geophysicists.

ARTICLE VII
MEETING

1. The Annual Meeting shall be held in May of each year, and shall be held on the second Thursday of May, unless otherwise specified by the Executive Committee and due notice given to the membership.
2. The Regular meetings of the Society shall be held on the second Thursday of each month except during the months of June, July, and August, unless otherwise provided by the Executive Committee.
3. Special meetings may be called at any time by the President of the Society.
4. The time and place of regular meetings, the nature of the technical program and the entertainment, shall be determined by the Executive Committee.

ARTICLE VIII
AMENDMENTS

1. This constitution may be amended by a three-fourths vote of the members present at any regular meeting, provided that the proposed amendment has been approved for submittal by the Executive Committee and has been moved at a regular meeting previous to the meeting at which the ballot shall be taken.
2. By-laws may be changed by majority vote of members present at any regular monthly meeting.
3. Nothing in this Constitution or By-laws shall be inconsistent with the Constitution and By-laws of the Society of Exploration Geophysicists.

BY-LAWS

I. The Officers and the Executive Committee may arrange for the affiliation with other duly organized groups or societies which by object,

aims, constitution or practice are aiding, assisting, or developing the profession of geophysics or allied technology.

II. Until such time as a sufficient number of qualified past Presidents has been created, so as to provide those members necessary to serve on the Executive Committee as provided in the constitution, these Executive Committee members shall be chosen by the Society by a majority vote from open nominations at the Annual Meeting.

III. Prior to the Annual meeting the Treasurer shall close his accounts and submit them to a Committee of three members of the Executive Committee designated by the President. These members shall audit the accounts and then certify their correctness by signing an entry in the cash book.

The new Treasurer shall accept the Society Funds by signing an entry to that effect in the cash book.

IV. The Society shall publish a journal. The journal shall be published at intervals designated by the Executive Committee. All reports to the Society by its officers and committees may be published in the journal. Each issue shall contain a membership list. Each issue shall list all committees. Original papers, reviews, abstracts, notes or information deemed by the Editor to be of interest to the members of the Society shall be published in the journal. The editor shall be sole judge of whether such material is to be published. The executive committee may authorize the printing of the journal and may authorize financing and distribution of the journal.

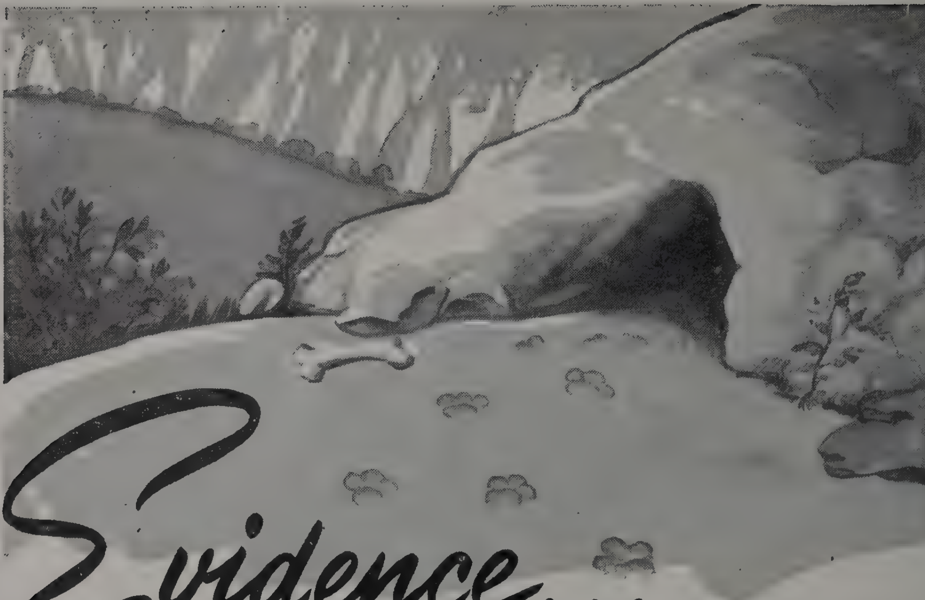
V. The first editor may be elected at a regular session of the Society following passage of this by-law at a regular meeting.

RULES FOR THE ADMITTANCE OF NEW MEMBERS

1. Any member interested in the Geophysical profession shall be eligible for membership in the Geophysical Society of Tulsa.
2. Applicatoins for membership shall be submitted in writing, and shall be signed by three sponsors who are members of the Society.
3. Applications shall be approved for membership by the Executive Committee.

ADVERTISERS INDEX

TABLE OF CONTENTS



THE PROCEEDINGS OF THE GEOPHYSICAL SOCIETY OF TULSA

☆

VOLUME 1, 1953

☆

JOSEPH A. SHARPE

Memorial Volume

THE MAGNETIC SUSCEPTIBILITY OF ROCKS, ITS DETERMINATION, AND USEFULNESS

JOSEPH A. SHARPE[1]

Types of Magnetization

Rocks have two types of magnetization. One, which is called remanent (or permanent), is unaffected, within limits, by the direction and magnitude of an external applied magnetic field, such as that of the Earth. In the case of igneous rocks, remanent magnetism appears to have been acquired when the solidifying material cooled through the Curie point, in the presence of the magnetic field of that epoch. Although the remanent magnetization of some individual specimens of igneous rock may be quite large compared to their induced magnetization, which is discussed below, there is some indication that the direction of remanent magnetization may be so erratic as to result in unimportant net contributions to the field at some distance from a large volume unit of igneous rock.[2]

The remanent magnetization of sedimentary rocks is quite definitely negligible.[3]

The second type of magnetization which rocks may have is called induced magnetization. This is dependent on the direction and strength of an external applied magnetic field. It is in the direction of that field and has an intensity proportional to the strength of the field. The factor by which the external field is multiplied to yield the intensity of induced magnetization is called the *magnetic susceptibility* of the material, and is a measure of its ease of magnetization. Expressed as an equation, $I = kH$, in which I is the intensity of magnetization, frequently called magnetic polarization; k is the volume magnetic susceptibility; and H is the strength of the applied field.

Magnetization of Sedimentary Rocks

The magnetization of a rock is due primarily to its magnetite content. As a result of the decomposition of magnetite which takes place during weathering, erosion, and transportation, the magnetization of sedimentary rocks is generally negligible compared to that of igneous rocks. The contribution of magnetization within the sediments to the magnetic map with few exceptions can usually be ignored.

Magnetic Units

In the cgs system, a magnetic pole of unit strength is one which separated 1 cm from an identical pole repels it with a force of 1 dyne. A north and south pole 1 cm apart have a magnetic moment of 1 cgs unit, magnetic moment being the product of the pole strength of one of two poles of opposite polarity by the distance of separation. Intensity of magnetization, I, is volume

[1]This is a posthumous paper assembled and arranged by the Editor from some brochures issued concerning a service for the determination of susceptibilities.

[2]Julian Hawes, "Magnetic Study of the Spavinaw Granite Areas, Oklahoma," **Geophysics**, Vol. XVII No. 1, January 1952, pp. 27-55.

[3]**Editor's note:** While the remanence of sedimentary rocks is usually negligible, as far as being a source of magnetic anomalies is concerned, it is of considerable interest and indeed may become important in deciphering the history of changes in the magnetic field of the Earth. It may be conceivably of importance in the correlation of series of sedimentary rocks. Experimental work by a number of investigators has shown that original remanence is retained for a very long time, even during periods of diastrophism and thus may be a property of the rocks which can be used for structural studies.

density of magnetic moment or, magnetic moment per unit volume. The pole strength per unit area on a surface of a uniformly magnetized body normal to the direction of magnetization is numerically equal to the intensity of magnetization of that body. It is only a matter of convenience whether one chooses to compute the effect of the poles on the surface or the effect of the volume distribution of the intensity of magnetization.

In the equation $I = kH$, when H is expressed in oersteds (sometimes they will be called gauss), I and k are in cgs units. Thus in the Earth's field of about 0.6 oersted, a rock having a susceptibility of 1000×10^{-6} cgs will have an intensity of magnetization, I, of 600×10^{-6} cgs units.

Calculation of Magnetic Anomalies Due to Geologic Structures

The induced magnetization of all rocks except ore bodies containing high percentages of magnetite is so low that one can assume uniform magnetization, a fact which simplifies calculations.

Magnetic calculations are based on the fact that the component of field along a selected direction n is the directional derivative in that direction of the magnetic potential V due to the assumed distribution of magnetized material, i.e. $H_n = \frac{\delta V}{\delta n}$. The potential due to the assumed distribution is computed either from the surface density of pole strength by suitable integration of the effect of an element of area according to $dV = dA\frac{s}{r}$, in which dA is the element of area of pole strength s, and r is the distance from the element of area to the point at which the potential is desired; or, it is computed from the volume density of magnetic moment by suitable volume integration according to $dV = dv\,\frac{\mathbf{I}.\mathbf{R}}{r^2}$ - in which dv is the element of volume, $\mathbf{I}$ is the intensity of the magnetization vector and $\mathbf{R}$ is the unit vector from the element of volume towards the point at which the potential is desired.

Since in most cases of geologic interest the structural relief is small compared to the depth, it is usually possible to greatly simplify the integrations by condensing the magnetizations on to a plane at the average depth of the structure.

The standard texts[1] on geophysical prospecting give formulas and curves which can be used conveniently to compute the magnetic anomalies due to various assumed geologic structures.

Measurement of Magnetic Susceptibility

The instrument developed by the Frost Geophysical Corporation for the measurement of the magnetic susceptibility of rocks consists of a regulated power supply operating from 110 v. AC mains, a stable 400 cps oscillator of constant output and low harmonic content, a Maxwell bridge in one arm of which is an inductor whose core will receive a ½" x 3" glass tube containing the rock sample, an amplifier, an electronic synchronous rectifier, and a zero center DC bridge balance indicator. Resistive and reactive components of

[1] Nettleton, L. L.—"Geophysical Prospecting for Oil," McGraw-Hill, N. Y., pp. 199-225.
Jakosky, J. J.—"Exploration Geophysics," Times-Mirror Press, Los Angeles, pp. 122-134.
Heiland, C. A.—"Geophysical Exploration," Prentice-Hall, New York, pp. 380-402.
Dobrin, Milton—"An Introduction to Geophysical Prospecting," McGraw-Hill, N. Y., 1952.
Nettleton, L. L.—"Gravity and Magnetic Calculations," Geophysics, Vol. 7 No. 3, pp. 293-310, July 1942.

the bridge are first independently balanced without the sample. The sample is then inserted, and the changes in effective resistance and inductance of the inductor due to the conductivity and susceptibility, respectively, of the sample, are compensated for by a re-balance of the bridge. From the calibrated dial reading of the reactive compensator and the mass and density of the sample, the volume susceptibility of the rock sample is calculated. The density of the rock is determined in water with the aid of a pyknometer bottle and a chemical balance.

The level of alternating magnetic field at which the susceptibility is determined is approximately equal to the intensity of the Earth's magnetic field. The accuracy of the determination when a full tube of sample is used is about 1×15^6 cgs units.

Usefulness of Magnetic Susceptibility Measurements

Since magnetic anomalies are caused mostly by lateral variations in the magnetization of rocks resulting from elevations of the surface of the Basement Complex, or from changes in the composition of rocks of the Basement Complex, a knowledge of the magnetic properties of rocks is of fundamental importance to the interpreter of the results of magnetic surveys. Further, determinations of the susceptibilities of cuttings may be used to distinguish whether drilling is proceeding in "granite" wash or whether "granite" in place has been encountered, a distinction of considerable importance in some oil producing provinces.[5]

A number of companies, realizing the importance of a knowledge of the magnetic properties of rocks to the interpretation of their magnetic surveys, have supplied material for susceptibility determinations with the understanding that the results were to be made generally available.[*] Unfortunately, complete information as to the lithologic nature of the material was not always available or transmitted, making some of the determinations not as significant as they could otherwise be.

Results of Measurements

In the following table are listed the results of measurements made of samples sent for testing. They have been arranged geographically. The descriptions are not in every case complete. Particularly some of the petrologic descriptions do not even distinguish between igneous, sedimentary, and metamorphic rocks.

Both cuttings and core fragments were used. About two tablespoonfuls were ample for a measurement.

In the case of cuttings it is hoped that cavings were removed where possible under the binocular microscope before the sample was submitted.

It is the intention to make available to the public additional tabulations of this kind as the data becomes available.

[5] G. L. Taylor and D. H. Reno "Magnetic Properties of 'Granite' Wash and Unweathered 'Granite,'" **Geophysics**, Vol. 13 No. 2, April 1948, pp. 163-181.
See also article by Deegan, **Oil and Gas Journal**, September 2, 1948, p. 84.

[*] Aero Service Corporation (Midcontinent), Tulsa, is continuing the service which may be used in two ways. A charge is made if the information is to be kept confidential. No charge is made if the information can be made public and the location and petrologic description of the sample is provided.

CANADA

ALBERTA

County	Company	Farm	Description	Depth	Material	Density gm-cm-3	Magnetic Susceptibility x10^6 cgs units
	Imperial	Claremont	16-25-72-5W6			2.57	10
	Imperial	Normandville	1-16-79-22W5			2.77	17
	Imperial	Spirits River	12-20-78-6W6			2.75	14
		No. 1 Biltmore	7-11-87-17W4			2.59	
QUEBEC							
Charlevoix			St. Urbain Area	Surface	Diorite-quartz	2.69	1879
Charlevoix			St. Urbain Area	Surface	Labordorite-anorthosite	2.64	58
Charlevoix			St. Urbain Area	Surface	Andesine-anorthosite	2.63	78
Charlevoix			St. Urbain Area	Surface	Undifferentiated	2.68	3036
Charlevoix			St. Urbain Area	Surface	Titaniferous Hematite ore from adnesine a northosite	4.40	642
Charlevoix			St. Urbain Area	Surface	Titaniferous Hematite ore from laboradorite a northosite	4.62	778

CUBA

ORIENTE PROVINCE

County	Company	Farm	Description	Depth	Material	Density gm-cm-3	Magnetic Susceptibility x10^6 cgs units
Los Negros District	Washington University St. Mo.	Toni Mine			Charco Redondo Limestone	2.11	
		Toni Mine			Core Volcanics near contact with Charco Redondo Limestone	2.68	248

ALASKA

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^6 cgs units
	USGS	S. Barrow No. 3		203′	Sedimentary	2.44	15
	USGS	S. Barrow No. 3		2413′	Precambrian	2.53	21
	USGS	S. Barrow No. 3		2879′	Precambrian	2.60	24
	USGS	Simpson No. 1		6545½′		2.70	34
	USGS	Umiat No. 1		258-90′	Sedimentary	2.45 avg.	16 avg
	USGS	Oumalik No. 1		920-1609′		2.43 avg.	17 avg

UNITED STATES

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^6 cgs units
ARIZONA							
				78′	Escobrosa Limestone	2.71	18
				133′	Martin Limestone	2.72	20
					Abrige Limestone	2.72	36
				325′	Glance Conglomerate	2.69	26
				340′	Naco Limestone	2.69	3
CALIFORNIA							
Kern	British-American	Davis No. 36-32	32-25S-27E	4491-96′	Granite	2.83	375
COLORADO							
Archuleta	Phillips	No. 1 Crowley		1607-09′	Sedimentary	2.58	8
Las Animas	Skelly	No. 1 Tercio		5975-6158′	Sedimentary	2.60 avg.	25 avg
Mesa	Amerada	No. 1 Unit Ashberry Creek	14-9S-101W	4203-06′	Metamorphic	2.65	17
	Shell	Green A-16	30-9S-53W	7802′	Granite	2.58	31

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^{6} cgs units
FLORIDA							
Jackson	Humble	No. 1 Tindal		8881-91′	Very Hard Gray Granite	2.80	1519
IDAHO							
	Hel. & Payne	No. 1 State		2550-60′	Xline No. Des.	2.48 avg.	1537 avg
	Hel. & Payne	No. 2 State	16-7S-9E	2060-68′	Xline No. Des.	2.63 avg.	642 avg
	Hel. & Payne	No. 1 Parker		2495-3785′	Xline No. Des.	2.58 avg.	4418 avg
ILLINOIS							
Coles	Magnolia		6-11N-11E			2.93	5737
MINNESOTA							
Gilbert	Univ. of Minnesota				Huronian	2.69	59
Gilbert	Univ. of Minnesota				Keewatin	3.05	101
Virginia					Gneissic	2.70	796
Virginia					Huronian	3.04	90
Ely					Algoman	2.71	1758
Ely					Keewatin	3.42	
Duluth					Keweenawan	2.83 avg.	1763 avg
Beaver Bay					Keweenawan	2.60 avg.	47 avg
Fond-du-Lac					Keweenawan	2.97	7542
Garlton	Univ. of Minnesota		Jay Cook Park		Keweenawan	2.95	1366
McGrath					Algoman	2.64	1548
Sauk Rapids					Granite	2.66	152
	Texas Co.	No. 1 Keenan	25-4S-27W	3920-25′	Precambrian	2.69	0
	Texaco	No. 1 Harmonson	23-4S-23W	3746′	Granite	2.71	1839
Hi. 61 at Int. Bound.		No. 83 C			Animikie	2.73	59

MISSISSIPPI

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^6 cgs units
Warren	Magnolia	No. 1 Ragsdale	24-16N-4E	7721-26′	Reworked Igneous	2.55	1392
Warren	Magnolia	No. 1 Ragsdale	24-16N-4E	8599-609′	Tuscaloosa Sandstone	2.53	344
Warren	Magnolia	No. 1 Ragsdale	24-16N-4E	8629-37′	Tuscaloosa Sandstone	2.60	64
Warren	Magnolia	No. 1 Ragsdale	24-16N-4E	8680-85′	Sandy Shale and Shaley Sand	2.50	222
Newton	Magnolia		25-7N-12E	Surface	Winona fm	2.32	1288
Newton	Magnolia		30-7N-13E	Surface	Winona fm Linonite	3.46	125
Newton	Magnolia		20-7N-13E	Surface	Winona fm	2.47	150
MISSOURI							
					Sec. Limonite Hematite ?	3.76	132
Dade				70′	Limonite	3.58	103
NEBRASKA							
	Shell	Phillips No. 1 Simmons	21-10N-22W	3365-71′	Granite	2.63	48
	Shell	Knauss No. 1 Atchison	28-10N-23W	3314′	Granite	2.55	176
	Shell	Carter Expl. No. 10	15-7N-20W	3855-80′	Granite	2.60	57 avg.
	Shell	Carter Expl. No. 11	9-8N-18W	3830-53′	Granite	2.78	2911
Cheyenne	Ohio	No. 1 Fender	2-14N-48W	6800-05′	Granite	2.59	40
	Sinclair	No. 1 Monohan	23-25N-35W	2445-53½′	Precambrian	2.64 avg.	40 avg.
	Akina Parker	No. 1 State	16-12N-26W	3520-41′	Precambrian	2.60 avg.	128 avg.
	S. P. O.	No. 1 Wiebe	13-13N-20W	3424-26′	Precambrian	2.64	25
	Carter	No. 6 Nebraska	11-18N-7W	3470-72′	Precambrian	2.52	53

NEW MEXICO

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^6 cgs units
Lea	Amerada	No. 1 BTB	26-12S-33E	11183-99′	Sedimentary ?	2.46	0
	Continental	No. 1 E Lockhart A-27	27-21S-37E	7788-92′	Basement ?	2.58	16
	Continental	No. 5 Skaggs B-23	23-20S-37E	10230′	Basement ?	2.66	38
	Magnolia	No. 1 Santa Fe Pac. "C"	26-9S-36E	4540-50′	Red and Gray Shale	2.77	9
Lea	Magnolia	No. 1 Santa Fe Pac. "C"		7900-10′	Red and Gray Shale	2.71 avg.	16 avg.
Lincoln	Pure	No. 1	El-Capitan Mtn.			2.54	8
Quay	Stanolind	No. 1 Fuller		6746-47′	Metamorphic	2.64	34
Roosevelt	Sparton Drlg.	No. 1 State 36		7120-38′		2.59 avg.	21 avg.
			36-4S-31E	7140-210′	Granite	2.62 avg.	37 avg.
				7217-61′	Granite	2.72 avg.	439 avg.
Roosevelt	Atlantic	Goldston No. 1 Lambirth	36-5S-32E	8278′	Black Igneous	2.99	6186
	Pure	Magnolia No. 1 Smith	11-7S-33E	10000-16′		2.55	
	Shell		5-8S-37E	8650′	Quartzite ?	2.61	82
	Mid-Cont.	No. 1 Strickland	9-4S-35E	7513′		2.71	26
Chaves	Magnolia	No. 1 Turney Federal	23-14S-22E	3780-90′	Red-Shale-Permian	260	32
				5300-10′	Granite with Metabasalt Intrusions	2.65	197
Chaves	Gulf	No. 1 Jennings	3-8S-30E	8300′	Granite ?	2.73	22
Chaves	Pure	RR. MTN. Dike		Surface		2.93	3655
Chaves	Pure	No. 1 Barnsdall	23-8S-32E	12010-40′	Precambrian	2.81	296
Chaves	Richfield	No. 1 Mullis	21-15S-29E	12143-53′	Precambrian	2.56	114
De Baca	Pure	No. 1 Federal Fee	31-3N-28E	6467′	Basement	2.62	277

County	Company	Farm	Description	Depth	Material	Density gm-cm-3	Magnetic Susceptibility x10^6 cgs units
Eddy	Magnolia	No. 1 State-W	16-21S-22E	11240-312′	Weathered Gabbro ?	2.80 avg.	1023 avg.
Eddy	Magnolia	No. 1 Crosby	23-21S-22E	500-20′		2.74	0
Eddy	Humble	10A Pearson	25-16S-25E	8243-48′	Shistose Quartzite	2.70	93
Guadalupe	Wirt Franklin	No. 1 Anton Chico	24-11N-18E	2000-200′	Black Quartzitic Granite	2.66	617
Lea	A. R. Dillard	No. 1	2-23N-33E	4035′	Sedimentary	2.57 avg.	39 avg.
San Juan Basin Section		McDermott				2.53 avg.	27 avg.
		Menefee				2.94 avg.	43 avg.
		Cliff House			Sandstone	2.92 avg.	25 avg.
		Pictured Cliffs			Sandstone	2.61	29
		Lewis Sh				2.57 avg.	23 avg.
		Fruitland				2.27 avg.	29 avg.
		Farmington			Sandstone	2.55	43 avg.
		Lower Mancos			Sandstone	2.57	20
		Dakota				2.56	3
		Pt. Lookout				2.57	26
		Kirtland Lower				2.90 avg.	43 avg.
		Kirtland Upper				2.49	20
		Upper Mancos				2.68	29
NEW YORK							
					Norite	3.12	1324
					Augite Norite	3.02 avg.	2158 avg.
					Augite Norite	2.86	3700
					Weathered Olivene Pyroxine	3.18 avg.	221 avg.
					Pyroxenite	3.08 avg.	1174 avg.

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility $x10^6$ cgs units
					Olivine Pyroxenite	3.12 avg.	1801 avg.
					Granite	2.65	342
					Gneiss	2.68 avg.	35 avg.
					Granite Gneiss	2.82 avg.	842 avg.
					Mica Schist	2.71	28
					Courtland Complex		
					Poikilitic Hornblend Norites	3.11	1487
					Poikilitic Hornblend Norite	2.96 avg.	1553 avg.
					Poikilitic Hornblend Norite Weathered	3.03 avg.	576 avg.
					Poik. Hornbl. Norite Lightly Weathered	3.01 avg.	1693 avg.
					Poik. Hornbl. Norite Badly Weathered	3.05 avg.	588 avg.
NORTH DAKOTA							
Morton	Phillips Carter	No. 1 Dakota	29-126N-81W			2.74 avg.	62 avg.
	Shell	Hunt Shoemaker	3-157N-78W	7203′	Granite	2.65	133
Kidder	Magnolia	No. 1-A State	36-141N-73W	5609½′	Precambrian ?	2.58 avg.	37 avg.
Evans	Roeser & Pendleton	No. 1 Weaver		5555-6′	Granite	2.70 avg.	2802
OKLAHOMA							
Beckham	Phillips	No. 1 Martin	27-9N-23W	4030-6825′		2.52 avg.	1820 avg.
Beckham	Howel & Howel	Speed	12-8N-23W	2200-680′		2.58 avg.	170 avg.

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^6 cgs units
Beckham	Carter	No. 1 States Taylor	31-9N-21W	6640-6923′		2.50 avg.	45 avg.
Beckham				8140-220′	Granite Wash	2.54 avg.	98 avg.
Beckham	Shell	No. 1 Oklahoma	8-10N-21W	9388-409′	Congl. Wash	2.58 avg.	25 avg.
		No. 1 A H.B. Gibbons	9-10N-21W	9676½-99′	Congl. Wash	2.50 avg.	24 avg.
		No. 2 B Okla.	8-10N-21W	9975-88′	Wash	2.57 avg.	29 avg.
Comanche	Carter		18-2N-9W			2.61	63
		No. 1 Emmons	26-2N-9W	7097-100′	Granite	2.82	3864
				7765½′	Granite		59
Comanche	Shell			Surface	Horneblende Biotite Granite Badly Weath.	2.63 avg.	131
				Surface	Porphyritic Granite Bad. Weath.	2.55	21
				Surface	Granophyke Badly Weath.	2.61	22
Comanche	Shell		1-2N-12W	Road Cut	Hornebl. Biotite Granite	2.60 avg.	1633 avg.
			1-2N-14W	Road Cut	Hornebl. Biotite Granite	2.54 avg.	41 avg.
Greer			9-6N-21W	Quarry	Hornebl. Biotite Granite	2.57 avg.	960 avg.
			16-6N-21W	Quarry	Hornebl. Biotite Granite	2.59 avg.	44 avg.
			23-6N-21W	Quarry	Hornebl. Biotite Granite	2.57 avg.	594 avg.
			26-6N-21W	Quarry	Hornebl. Biotite Granite (Permatite)	2.58 avg.	39 avg.
			28-6N-21W	Quarry	Hornebl. Biotite Granite	2.59 avg.	30 avg.

County	Company	Farm	Description	Depth	Material	Density gm-cm-3	Magnetic Susceptibility x10⁶ cgs units
Kiowa			1-2N-19W	Surface	Fine Grain Hornebl. Biotite Granite Bad. Weath.	2.55 avg.	61 avg.
			4-2N-17W		Quartz Orthoclose Granite Rosevelt Gran.	2.59 avg.	37 avg.
			4-4N-17W	Road Cut	Anorthosite Gabbro	2.74 avg.	1639 avg.
Kiowa			20-2N-16W	Quarry	Quartz Orthoclose Granite	2.58 avg.	186 avg.
			20-5N-16W	Surface	Quartz Orthoclose Granite	2.56 avg.	111 avg.
			20-5N-18W	Quarry	Hornebl. Biotite Granite	2.54 avg.	19 avg.
			20-5N-19W	Surface	Hornebl. Biotite Granite	2.56 avg.	45 avg.
			21-4N-17W	Quarry	Gabbro	2.72 avg.	181 avg.
			21-2N-18W	Road Cut	Hornebl. Biotite Granite	2.54 avg.	43 avg.
			23-2N-16W	Surface	Quartz Orthoclose Granite Bad. Weath.	2.57 avg.	313 avg.
			27-4N-16W	Road Cut	Anorthosite Gabbro	2.68 avg.	213 avg.
			28-5N-16W	Road Cut	Quartz Orthoclose Granite	2.61 avg.	74 avg.
			28-5N-20W	Quarry	Horne. Granite	2.57 avg.	22 avg.
			28-4N-17W	Surface	Hornebl. Biotite Granite Bad. Weath.	2.60 avg.	1230 avg.
Kiowa			29-4N-17W	Surface	Fine Grain Gabbro	2.86 avg.	86 avg.

County	Company	Farm	Description	Depth	Material	Density $gm\text{-}cm^{-3}$	Magnetic Susceptibility $x10^6$ cgs units
			31-5N-17W	Quarry	Gabbro	2.70 avg.	1885 avg.
			31-5N-18W	Quarry	Hornebl. Biotite Granite	2.62 avg.	81 avg.
Stephens	Carter	No. 1 Willeford	24-2N-9W	8537-47′		2.59 avg.	29 avg.
				8723-38′		2.56 avg.	35 avg.
				8982-96′		2.55 avg.	31 avg.
				9215-42′		2.61 avg.	43 avg.
				9526-42′		2.57 avg.	28 avg.
				9752-82′		2.58 avg.	28 avg.
				10026-39′		2.73 avg.	88 avg.
				10136-144′		2.71 avg.	145 avg.
Roosevelt	Sparton Drlg.	No. 1 State 36	36-4S-31E	7214′		2.58	52
Tulsa	Superior	No. 1 Blakemore	26-21-13	1407′		2.54	1746
	GMX		18-21N-4E			2.42	1261
			19-19N-5E		Weathered 6599	2.78 avg.	78 avg.
			20N-4E			2.92 avg.	746 avg.
			35-22N-2E			2.54	145
	Phillips	Martin		3940-4010′	Granite Wash	2.29 avg.	90 avg.
SOUTH DAKOTA							
					Homestake fm Chlorite-pyrrhotite Schist pyrr. bands	3.33	3482
					Homestake fm Chlorite pyrr. Schist vein Quartz	3.08	1433
					Homestake fm Chlorite cumming-tonite schist	3.14	239

County	Company	Farm	Description	Depth	Material	Density gm-cm-3	Magnetic Susceptibility x10⁶ cgs units
					Arsenopyrite Vis. gold Mica garnet schist-	2.83	213
					Ellison fm Sericite schist	2.81	67
					Ellison fm Quartzite	2.65	24
					Ellison fm Biotite Schist	2.81	58
					Ellison fm Tertiary Rhyo- lite quartz- feldspar rhyo- lite-pyrite	2.60	16
Perkins	Shell	No. 1 H.D. Veale	7-17N-15E	8292-317′	Granite	2.64	25
Perkins	Shell	No. 1 J.T. Homme	13-20N-12E	9345′	Granite	2.66	37
Corson	Shell	No. 1 J.K. Winter	11-22N-19E	8433-45′	Granite	2.58	42
Black Hills					Poorman fm Sedimentary Quartz Mica Schist	2.94	112
					Poorman fm Banded Phyllite	2.87	208
					Poorman fm Graphite-pyrr- hotite schist	4.10	1278
					Poorman fm Banded Phyllite	4.11	1095
					Poorman fm Carbonate phyllite	2.66	27

County	Company	Farm	Description	Depth	Material	Density $gm\text{-}cm^{-3}$	Magnetic Susceptibility $x10^6$ cgs units
Black Hills					Homestake fm Cummingtonite Schist	3.02	229
					Homestake fm Cummingtonite Sideceplesite schist	2.98	205
					Homestake fm Sed. Quartz Cummingtonite schist	3.10	122
					Northwestern fm mica garnet Schist	2.68	44
					Flagrock fm Quartz Mica Cummingtonite Schist	2.77	64
					Flagrock fm Mica Garnet Schist W. Staurolite	2.97	136
					Grizzly fm Sandy Mica Phyllite	2.58	36
					Hornebl. Schist Quartz Biotite Vein Amphibolite	2.95	110
					Hornebl. Schist Amphibolite	3.00	85
					Tertiary Dike Phonolite	2.58	28
					Deadwood fm Strawberry Iron Ore	4.11	44

County	Company	Farm	Description	Depth	Material	Density gm-cm-^{3}	Magnetic Susceptibility x10^{6} cgs units
TEXAS							
Andrews	Shell	No. 1 Cox	PSL BLK A-31	11161′	Ryolite Gran.	2.63	690
Armstrong	Stanolind	No. 1 Corbin		6118-19′	Rhyolite Porphyry	2.53	43
Bailey	Phillips	No. 1 Stevens		8130-40′	Granite	2.52	88
Brazoria				1710-2036′	Limestone Carrock	2.69 avg.	10 avg.
					Shale	2.30 avg.	21 avg.
					Limonite Sec.	3.09	146
					Anhydrate	2.47	12
					Anhydrate	2.93 avg.	9 avg.
Brewster				Surface	Tertiary Extrus.	2.57	757
					Crossen Trachyte	2.57	235
					Boquillos Flocs	2.72	1395
					Cottonwood Sprgs. Basalt		
					Consol. Ashby Tuff	2.13	81
					Duff Tuff	2.16	106
Caldwell				1400′	Serpentine	2.16	1941
Carson	Stanolind	No. 1 Griffin		5646-47′	Rhyolite Porphyry	2.50	41
Castro	Seaboard-Humble	Topper	AB&M Ry. Sur.	6655′		2.67	42
	Sun	No. 1 Herring	Sec. 46 Blk T-4 T. A. Thompson	9800-10180′	Basement	2.63 avg.	387 avg.
				10400-420′	Gabbro	2.67	1156
		No. 1 Hobar		9124-25′	Basement ?	2.78	37
Clay	Bridewell	No. 1 Edrington	F. W. Grass-meyer Surv.	2183-84′	Gneiss	2.67	25
	Perkins	No. 1 Stine	Bacons S/D Lot 62	2935-40′	Basement ?	2.65	42

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^6 cgs units
	Republic Nat. Gas	Madden & Goldsmith	Parker CSL Survey	2572′	Basement ?	2.55	29
Cochran	Humble	No. 1 Westhiemer	Stonewall CSL Sur. Lge. 146	7353′	Basement ?	2.57	15
Cooke	Phillips	No. 1 Danglemeyer	Elover Langford Surv.	2517-19′	Basement ?	2.58	29
Cottle	Anderson-Prichard	No. 1 Lynch Bros.	Sec. 66 ABS 1561	5702-66′	Sedimentary	2.59 avg.	25 avg.
	Prichard	No. 1	Sec. 66 Poiteventsur	5766-70′	Igneous ?	2.59	200
			Sec. 66 ABS 1561	5782-834′	Wash	2.59 avg.	44 avg.
				5822-34′	Basement	2.59 avg.	138 avg.
	Cabot Carbon	No. 1 Brown		2005-200′	Sedimentary ?	2.63 avg.	20 avg.
				2300′		2.63	155
		No. 2 Brown		2005-105′ 2205′	Sedimentary ?	2.61 avg.	21 avg.
						2.38 ?	218 ?
		No. 3 Brown		2005-305′	Sedimentary ?	2.54	23 avg.
		Lo Eakin		2305-850′	Sedimentary ?	2.45 avg.	23
	J. M. Huber	No. 1 Fuller		2915-80′	Sedimentary ?	2.50 avg.	23 avg.
	Ramsey	No. 1 Lynch	Sec. 66J Poitevent Survey	5689-94′	Quartzdiorite	2.66	207
	Seaboard	No. 1 Topper		6655′	Basement ?	2.67	24
Crosby	Humble	No. 1 Montgomery	Sec. 21 Blk. 2 B&B Survey	9704-10180′	Felspathic Sandstone	2.61 avg.	28 avg.
Dallam	G. P. Livermore	No. 1 Moser		6700-800′	Gran. Wash	2.60	59 avg.
Deaf	Honolulu	No. 1 Ponder		9571-74′	Sandstone	2.56	16
Denton	Hunt	No. 1 Martin	J. Parks Sur.	2978′	Gabbro ?	2.60	75
	Stanolind	No. 1 Dunn		3415-16′	Top Precamb. ?	2.90	47
Dickens	Humble	No. 3 Matador	Sec. 2 Blk. J W. Jackson Sur.	7735′	Basement	2.64	591
Donley	Humble	T. S. Roach		5162-65′		2.61	61

County	Company	Farm	Description	Depth	Material	Density $gm\text{-}cm^{-3}$	Magnetic Susceptibility $x10^{6}$ cgs units
	Honolulu	No. 1 Ozier	Sec. 55 Bk. C-6 G.C.&S.F. Sur.	5890-93′	Granite	2.58	1350
	Humble	No. 1 Roach		5262-65′	Basement	2.61	61
	Shamrock	No. 1 Adair	Sec. 15 Blk. A J. B. Adair Sur.	5356-58′	Gran. Wash. ?	2.65	13
	Stanolind	No. 1 Tray Broome		6751-53′	Granite	2.73	1323
Fisher	Humble	No. 1 Crowley	Sec. 42 Bk. 2 H&TC Sur.	7081-85′	Prob. Basement	2.68	97
Floyd	Houston O. G. of T.	No. 1 Lackey		10395′	Granite Contamin.	2.63 avg.	639 avg.
	Gen.-Amer.	No. 1 Humble-Byrd	Sec. 17 Blk. 17 TT RR Sur.	6660-70′		2.52 avg.	10 avg.
Floyd	Gen.-Amer.	No. 1 Humble-Byrd	Sec. 17 Bk. 17 TT RR Sur.	6670-75′		2.53	226 ?
				6700-15′	Coarse Sample	2.52 avg.	13 avg.
				Bottom	Basement	2.67	762
		No. 1 Mayo		5750-6090′	Basement ?	2.62 avg.	54 avg.
		No. 1 Strickler	Sec. 19 Blk. K TT RR Sur.	7170-675′	Basement ?	2.54 avg.	78 avg.
	Livermore	No. 1 Krause	Sec. 29 Blk. K TT RR Sur.	7838′	Sedimentary ?	2.60	27
	Standard of Texas	No. 1 Daniel	A. B. Duncan	6990-92′	Metamorphic-Schistose Quartzite	2.55	10
Garza	Gulf	No, 1 Swenson B	Sec. 95 Bk. 1-C H&GN Sur.	8098-104′	Basement	2.72	125
Gray	Warner Oil Co.	No. 1 Morse	Sec. 18 Bk. 25	2297-355′	Gran. Wash	2.56 avg.	29 avg.
				2355-512′	Gran. Wash	2.58 avg.	55 avg.
				2512-851′	Basement ?	2.58 avg.	85 avg.
Hale	No. 1 Clements			10000-150′	Granite	2.70 avg.	1009 avg.
	Amerada	No. 1 Kurfees	Sec. 6 Bk. N TT RR Sur.	10245-5′	Gabbro	2.89	1489
Hale	Stanolind	No. 1 Fisher	Sec. 5 Bk. C-L E.L. RR Sur.	6692′	?	2.73	58

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^6 cgs units
Hale		No 2 Fisher	Sec. 5 Bk. C-L E.L. RR Sur.	7585-955′	Sedimentary	2.62	26 avg.
				8045-385′	Rhyolite Porphyry	2.64 avg.	174 avg.
		No. 1 Hegi	Sec. 7 Bk. 5 E.L. RR Sur.	9630-70′	Rhyolite Porphyry	2.65 avg.	13 avg.
		No. 3A Irish	Sec. 18 Bk. DT HE&WT Sur.	6007-150′	Sedimentary	2.54 avg.	2 avg.
Hall	Humble	No. 1 Weaver			Basement	2.61	77
Hartley	Sinclair	No. 1 Bevins	Sec. 5 Bk. 25	5924-26′	Sedimentary ?	2.57	31
		No. 2 Bevins		2863-65′	Gray Igneous Sill ?	2.70	0
King	Humble	No. 4 Bateman	Sec. 101 Bk. A J. B. Rector Sur.	6388′	Basement	2.47	178
		No. 43 Bateman	Sec. 114 J. B. Rector Sur.	6629-31′	Basement	2.62	67
		No. 1 Ross	Sec. 27 S.L.G. Raves Sur.	6600-01′	Basement ?	2.58	16
Lamb	Honolulu	No. 1 Halsell	Lab. 19 Lge. 219 Castro Co. S.L.	9095-137′	Rhyolite Porphyry	2.50 avg.	49 avg.
	Humble	No. 1 Jackson			Basement ?	2.66	43
	Stanolind	No. 1 Hopping	Sec. 25 T.A. Thompson Sur. Blk. T	9602-06′	Basement	2.69	584
Lubbock	Honolulu	No. 1 Rhodes	Sec. 8 Bk. E G.C.&S. Sur.	10465′	Sedimentary ?	2.57	12
Lynn	Honolulu	No. 1 King	Sec. 424 Bk. 21 HE&NT	10756′	Sedimentary	2.55	12
Montague	Shell	No. 1 Hodges		4988-89′	Granite	2.67	309
	Phillips	No. 1 Fields	Sec. 54 J.T. Graham Sur.	3792′	Basement ?	2.58	11
	Guerin	No. 1 Seitz		2514′	Basement ?	2.67	19
Motley	Humble	B-1 Matador	Blanco Co. S.L. Sec. 127	6269′	Basement ?	2.63	1230

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^6 cgs units
Oldham	Humble	E-1 Matador		6281′	Granite	2.60	442
Potter	Canadian River Gas	No. 4B Masterson		1952′	Rhyolite Porphyry	2.58	429
Potter	Sinclair	No. 2 Bevins	Sec. 28 Bk. 0 182 D&P Sur.	863-65′	Gray Igneous Sill ?	2.70	0
				2885′	Red Granite	2.55	33
				2885′	Sedimentary	2.58	26
Presidio	Argo	No. 1 State	40-1	1500-2000′	Tertiary Intrus.	2.58 avg.	2320 avg.
			Paradise Valley		Mitchell Mesa Rhyolite	2.31	23
					Tascotal Tuff	2.11	273
			12.3 mi. S. Marfa on Hy. 67		Tascotal Basalt	2.66	2305
			34 mi. S Marfa on Hy. 67		Rhyolite	2.40	641
			Town of Shafter			2.65	7
		Mitchell State	40-1-9	670-80′	Duff Tuff	2.10	259
			40-1	1620-30′	Lava Cotton-wood Sprgs. ?	2.64	3361
				2140-50′	Grossen Trachyte ?	2.50	1110
				2750-60′	Pruitt Form.	2.30	415
Presidio	Argo	Mitchell State	40-1	3110-20′	Cretaceous	2.32	35
				3970-80′	Permian	2.50	21
				6040-50′	Upper Wolfcamp	2.63	46
				7040-50′	Lower Wolfcamp	2.64	31
				7650-60′	Cisco Fm	2.62	45
				8605-10′	Canyon Fm	2.59	29
				8945-50′	Strown	2.65	29
Shackleford	Honolulu	No. 1 Pool	Sec. 35 Univ. Lands	5273-76′	Basement	2.85	113

County	Company	Farm	Description	Depth	Material	Density gm-cm-^{3}	Magnetic Susceptibility x10^{6} cgs units
Sherman	Phillips	No. 1 Kathryn			Precambrian	2.57	25
Stonewall	Honolulu	No. 1 Baugh	Sec. 375 Bk. 2 H&TC Sur.	6880′		2.62	
Travis	Anderson-Prichard	No. 1 Johnson	Pedro Rodriguez Co.	989-1001′	?	2.32 avg.	41 avg.
				1001-109′	Serpentine	2.36 avg.	796 avg.
		No. 1 Schiller	Blks. 12 & 13 Pedro Rodriguez Sur.	1050-211′	?	2.52 avg.	10 avg.
Travis	Anderson-Prichard	No. 2 Schiller	Blks. 12 & 13 Pedro Rodriguez Sur.	1107-127′		2.50 avg.	20 avg.
		No. 3 Schiller	Blks 12 & 13 Ped. Rod. Sur.	900-1080′	?	2.50 avg.	23 avg.
				1080-200′	Serpentine Wash ?	2.50 ?	39 avg.
		No. 1 Theo Schwenke	Tract in Sappington Jordon & Wyche Sur.	1095-100′	Serpentine	2.32	1409
Wichita	Fraber-Hodges	No. 1 George		3318′	Bluish-Green Granite	2.81	1340
Willbarger	Barkley-Meadows	No. 14 A Stephen		2970-3007′	Schist ?	2.80	1338
	Gulf	C. F. Blackman	Sur. 3 ABS 175-B W.A. McKinney Sur.	3548′	Basement	2.55	265
	Texas	No. 1 Main			Basement ?	2.64	24
Williamson	Anderson-Prichard	No. 1 B Pruesse	Robbins Pasture 1 Subdiv. R. W. Booth Sur.	1190-94′	Serpentine	2.34 avg.	1170 avg.
Yokum	Atlantic	No. 1 Rogers	Sec. 106 Bk. D	13016′	Precambrian	2.57	0

County	Company	Farm	Description	Depth	Material	Density gm-cm^{-3}	Magnetic Susceptibility x10^{6} cgs units
UTAH							
Southern	Equity		26-21S-23E		Granite	2.70 avg.	53 avg.
			20-21S-23E		Nash Wash Metanoephosed Precambrian	2.72	427
WYOMING							
Goshen	Gen. Petr.	No. 1 Van Tussel	32-30N-60W	575-85′	Tertiary Sandstone	2.26	167
		No. 1 Lively	33-28N-60W	440-50′	Tertiary Sandstone	2.13	225
Natrona	Pure		36-37N-84W	4634-37′	Precambrian	2.59	124
	Atlantic		24-3 ON-85W	Surface	Schist ?	2.69	39
				Surface	Permatite Granite	2.57	15
			16-29N-16W	Surface		2.52	31
			20-29N-86W	Surface		2.60	32
			35-29N-87W	Surface		2.57	32
			5-29N-86W	Surface		2.56	23
Fremont	Atlantic		32-30N-92W	Outcrop	Granite Weath.	2.42	0
				Outcrop	Gneiss	2.41	93
			14-28N-93W	Surface		2.62 avg.	11 avg.

MAGNETIC SUSCEPTIBILITY MEASUREMENTS ON LLANO UPLIFT ROCKS[1]

VIRGIL E. BARNES[2]

The Bureau of Economic Geology has been making gravity and magnetic surveys in the Llano uplift in order to correlate the geophysical data with the geology. A report was made on this work by Barnes, Anderson, and Romberg[3], but magnetic susceptibility measurements for the rocks were not available at that time, and their magnetic properties were interpreted from magnetometer data.

A Frost magnetic susceptibility bridge was made available through the generosity of Messrs. C. H. Frost and J. C. Rollins of the Frost Geophysical Corporation and the Frost Airborne Surveys, Inc., Tulsa, Oklahoma, thus making it feasible to determine the magnetic susceptibility of the various rock units. A total of 185 determinations of magnetic susceptibility were made.

The writer is indebted to Mr. W. R. Varnell who operated the magnetic susceptibility bridge, to Mr. A. R. Embrey, Jr., who made the density determinations, to Dr. S. S. Goldich and the Minnesota Rock Analysis Laboratory for analyses, and to Dr. P. T. Flawn for supervising the operating of the bridge and for consultation on the results. All of the analytical data discussed in this paper are published in The University of Texas Publication 4246.

In the table below, the data are summarized for the various rock units, giving ranges and average values for both density and magnetic susceptibility, and for some units a revised figure with the elimination of exceptional samples.

MAGNETIC SUSCEPTIBILITY AND DENSITY DATA FOR LLANO UPLIFT ROCKS

ROCK UNIT	Number of Samples	DENSITY Range	DENSITY Average	SUSCEPTIBILITY PER $cm^3 \times 10^{-6}$ (ELECTROMAGNETIC cgs UNITS) Range	Average
PRE-CAMBRIAN ROCKS					
Packsaddle schist	51	2.18-3.08	2.77	0-14,000	1,024
*Packsaddle schist	43	2.18-3.08	2.74	0-260	54
Amphibolite	10	2.84-3.08	2.99	53-12,000	2,832
*Amphibolite	6	2.84-3.08	2.97	53-260	138
Biotite schist	7	2.61-2.95	2.83	55-14,000	2,079
*Biotite schist	6	2.61-2.93	2.81	55-230	92
Calcitic marble	9	2.55-2.79	2.73	0-56	18
Dolomitic marble	5	2.71-2.94	2.80	13-120	42
Garnet schist	1	2.97	2.97	70	70
Graphite schist	4	2.18-2.40	2.26	0-10	3
Quartzite	2	2.59-2.68	2.63	8-4,200	2,104
Not classified	13	2.61-3.03	2.74	16-2,100	230
*Not classified	11	2.61-3.03	2.73	16-87	43
Valley Spring gneiss	22	2.60-2.70	2.64	13-4,700	1,444

[1]Publication authorized by the Director, Bureau of Economic Geology, The University of Texas.

[2]Geologist, Bureau of Economic Geology, The University of Texas, Austin, Texas.

[3]Barnes, V. E., Anderson, W. A., and Romberg, Frederick, Correlation of gravity and magnetic observations with geology of Blanco and Gillespie counties, Texas: XIXth International Geological Congress, Abstracts, p. 56, Algiers, 1952.

ROCK UNIT	Number of Samples	DENSITY Range	DENSITY Average	SUSCEPTIBILITY PER $cm^3 \times 10^{-6}$ (ELECTROMAGNETIC cgs UNITS) Range	SUSCEPTIBILITY Average
Big Branch gneiss	2	2.67	2.67	1,000-1,500	1,250
Red Mountain gneiss	4	2.60-2.67	2.62	51-760	435
Serpentine	5	2.17-2.57	2.41	63-5,600	2,673
Soapstone	2	2.72-2.85	2.78	26-660	343
Soapstone replaced by quartz	1	2.64	2.64	1,600	1,600
Impure magnetite	1	3.85	3.85	68,000	68,000
Basic rocks	25	2.70-3.08	2.92	38-11,000	2,584
*Basic rocks	19	2.70-3.08	2.92	38-11,000	2,385
Dikes	6	2.70-2.98	2.83	54-1,100	291
Diorite	8	2.80-3.00	2.92	83-11,000	5,429
*Diorite	5	2.86-3.00	2.94	3,700-11,000	8,580
Hornblendite	7	2.87-3.08	3.01	68-6,100	1,169
*Hornblendite	5	3.03-3.08	3.05	68-85	77
Not classified	4	2.72-3.05	2.90	38-11,000	2,821
*Not classified	3	2.72-3.05	2.88	38-160	95
Acid rocks	67	2.58-2.77	2.63	16-5,200	611
Town Mountain granite	40	2.58-2.77	2.63	18-5,200	553
†Town Mountain granite	27	2.58-2.66	2.62	19-810	179
‡Town Mountain granite	13	2.59-2.77	2.65	18-5,200	1,331
Oatman Creek granite	13	2.58-2.69	2.61	27-1,400	523
Sixmile granite	8	2.61-2.74	2.66	41-2,100	906
Llanite dike	1	2.64	2.64	840	840
Aplite	2	2.60-2.63	2.61	16-420	218
Felsite (?)	3	2.61-2.68	2.65	20-2,600	1,157
PALEOZOIC ROCKS					
Upper Cambrian-Riley formation					
Hickory sandstone	1	2.43	2.43	28	28
Cap Mountain limestone	2	2.65-2.68	2.66	24-30	27
Lion Mountain sandstone	1	2.55	2.55	68	68
PALEOZOIC OR YOUNGER ROCKS					
Diabase	1	2.74	2.74	8,400	8,400

The susceptibility ranges of many of the rock units overlap, and the average values mean little, but if exceptional values are eliminated the average values

*Eliminating samples which are exceptional.

†Town Mountain granites of quality to be used as building stone and described in The University of Texas Publication 4246.

‡Other Town Mountain granite, much of it showing assimilation of country rock.

appear to have more significance. For example, the average for all Packsaddle schist samples is 1,02x10^{-6}, and with the elimination of only 16 percent of the samples the value becomes 54x10^{-6}. A critical evaluation of the data for the Packsaddle group of rocks suggests that the value for the Packsaddle schist as a whole is about 120x10^{-6}.

The average susceptibility values for the Town Mountain granites described in The University of Texas Publication 4246 is 179x10^{-6}, and this value is probably not far from that of the average Town Mountain granite mass. Extensive assimilation is known in only one Town Mountain granite mass and 7 samples of this material have an average susceptibility of 2,030x10^{-6}; in averaging the values for the Town Mountain granite not more than one of these should be included.

Five samples of hornblendite have an unexpectedly low susceptibility and two which are considerably altered have a high susceptibility. The Big Branch gneiss unfortunately is represented by only two samples, and as the sampling was for other purposes several other units are not well represented.

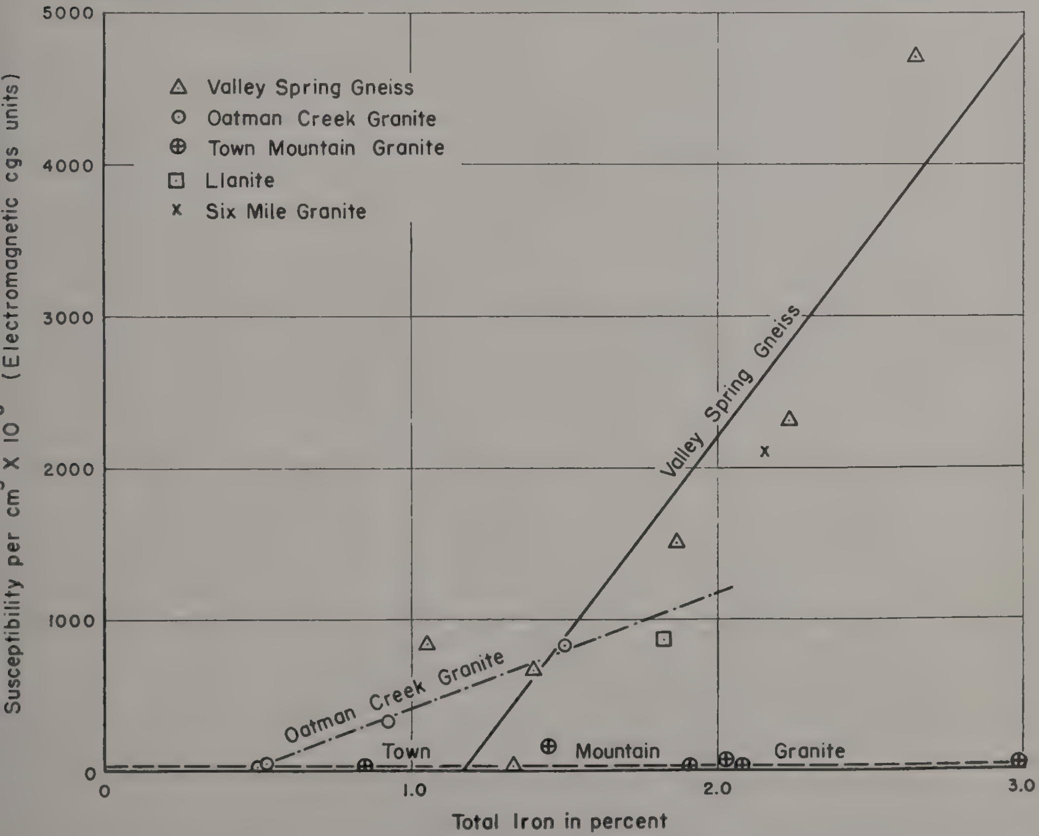


Fig. 1. Relationship of total iron to magnetic susceptibility for analyzed pre-Cambrian rocks, Llano uplift, Texas.

Superior analyses are available for 18 samples of pre-Cambrian rock, for which susceptibility determinations were made. As iron and perhaps to a lesser extent titanium are responsible for magnetic susceptibility, an attempt was made to show the individual relationships of the oxides of iron (FeO and Fe_2O_3), total iron and titania to susceptibility. Only the diagram depicting the relationship of total iron to susceptibility is reproduced (fig. 1). The points on all the diagrams are scattered and there is little relationship between magnetic susceptibility and any of the oxides or elements, unless each rock type is considered separately. Normal Town Mountain granite, for example, has about the same low magnetic susceptibility no matter how high the iron content. The Oatman Creek granite has a moderate increase of magnetic susceptibility with increase of total iron, and the Valley Spring gneiss has a large increase of magnetic susceptibility with increase of total iron.

Magnetite is the most magnetic mineral and the relationship of the actual amount in the rock to the susceptibility should be constant. However, mag-

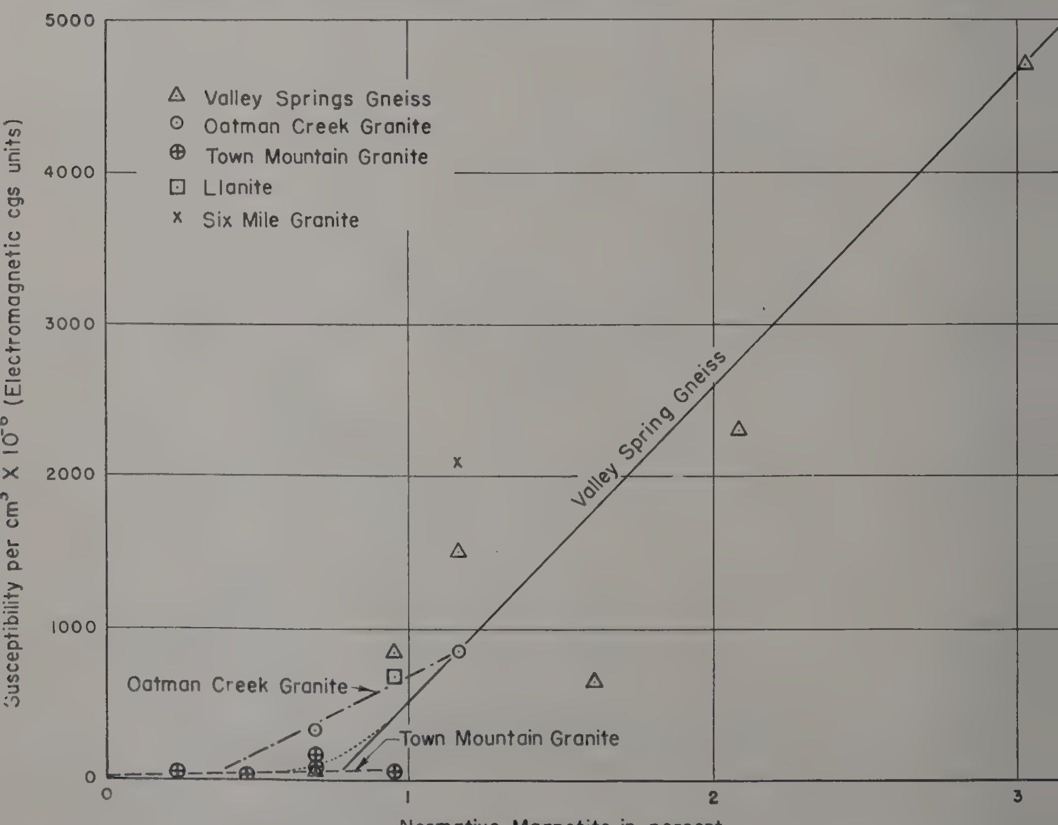


Fig. 2. Relationship of normative magnetic to magnetic susceptibility for analyzed pre-Cambrian rocks, Llano uplift, Texas.

netite is difficult to distinguish microscopically from other dark minerals and it was not feasible to separate and weigh the magnetite in the samples. For comparing rocks chemical analyses are commonly calculated into normative minerals including magnetite, but these minerals may or may not be present. In figure 2, the relationship of normative magnetite to susceptibility is shown, and the relationship is about the same as in figure 1, except that the curves for Town Mountain granite, Oatman Creek granite, and Valley Spring gneiss can easily be rounded into one curve. The difference in slope of this curve has not been explained, and it is obvious that fundamental mineralogic research is needed before many of the anomalous susceptibility determinations can be explained.

The average density and susceptibility of the large basement rock masses should be known in order to interpret magnetic and gravity surveys correctly. The following average values are about the best that can be derived from the data obtained during this investigation. The rock units are arranged in approximate order of size—the largest one being first.

Rock Unit	Number of Samples	Density	Suspectibility per $cm^3 \times 10^{-6}$ (Electromagnetic cgs units)
Packsaddle schist	23	2.82	120
Valley Spring gneiss	22	2.64	1,450
Town Mountain granite (normal)	27	2.62	180
Big Branch gneiss	2	2.67	1,250
Serpentine	5	2.41	2,700
Town Mountain granite (contaminated)	7	2.67	2,000
Diorite	8	2.92	8,600
Oatman Creek granite	13	2.61	520
Sixmile granite	8	2.66	900

MAGNETIC SUSCEPTIBILITY MEASUREMENTS ON WELL CORES FROM PRE-SIMPSON PALEOZOIC ROCKS[1]

VIRGIL E. BARNES[2]

The Bureau of Economic Geology with generous oil company support initiated a project in May 1952 to study the stratigraphy of the pre-Simpson subsurface rocks in Texas, to see if these rocks can be divided into recognizable stratigraphic units. Various techniques, including measurement of magnetic susceptibility, are being used in an effort to identify units within this rock sequence.

A Frost magnetic susceptibility bridge was made available through the generosity of Messrs. C. H. Frost and J. C. Rollins of the Frost Geophysical Corporation and the Frost Airborne Surveys, Inc., Tulsa, Oklahoma.

The writer is indebted to Mr. W. R. Varnell who operated the magnetic susceptibility bridge, to Mr. A. R. Embrey, Jr., who made the density determinations, to the American Spectrographic Laboratory for analyses of the samples, to Mr. Edwin Van den Bark of the Phillips Petroleum Company for furnishing the excellent 1,360-foot core from their No. 1 Wilson well in Val Verde County, to Dr. Ralph Taylor of the Humble Oil and Refining Company for furnishing the excellent 580-foot core from their No. D-1 Alma Cox well in Crockett County, and to Dr. P. T. Flawn for supervising the operating of the bridge and for consultation about the results.

Initially a few cores having a wide range in iron content were chosen to see if there is a measureable difference in magnetic susceptibility. The initial measurements show that all the cores have a measurable susceptibility, that there is a considerable range in susceptibility, and a suggestion that the amount of susceptibility is proportional to the iron content. These results encouraged the measurements of the susceptibility of all the analyzed cores, a total of 74 samples on which 81 determinations were made.

The following table lists the depth in feet, density, magnetic susceptibility, iron content stated as Fe_2O_3, and rock type of each core.

MAGNETIC SUSCEPTIBILITY AND DENSITY OF PRE-SIMPSON PALEOZOIC CORES

Depth in Feet	Density	Susceptibility per $cm^3 \times 10^{-6}$ (Electromagnetic cgs Units)	*Fe_2O_3 in percent	Rock Type
		Phillips Petroleum Company No. 1 Wilson Val Verde County		
14,981	2.85	46	0.33	Dolomite
15,011	2.70	36	0.46	Limestone
15,045	2.86	31	0.52	Dolomite
15,081	2.83	53	0.69	Dolomite
15,112a	2.86	41	0.56	Dolomite
15,112b	2.86	36	0.56	Dolomite

[1]Publication authorized by the Director, Bureau of Economic Geology, The University of Texas.
[2]Geologist, Bureau of Economic Geology, The University of Texas, Austin, Texas.
[3]Broding, R. A., Zimmerman, C. W., Somers, E. V., Wilhelm, E. S., and Stripling, A. A., Magnetic well logging: Geophysics, vol. 17, pp. 1-26, January, 1952.
*Determined spectrographically by American Spectrographic Laboratories.

Depth in Feet	Density	Susceptibility per cm^3 x 10^{-6} (Electromagnetic cgs Units)	*Fe_2O_3 in percent	Rock Type
15,209a	2.85	33	0.35	Dolomite
15,209b	2.85	28	0.35	Dolomite
15,237	2.78	20	0.31	Dolomite
15,268	2.83	42	0.43	Dolomite
15,308	2.82	21	0.23	Dolomite
15,343a	2.83	32	0.41	Dolomite
15,343b	2.83	35	0.41	Dolomite
15,371	2.85	33	0.42	Dolomite
15,402	2.83	23	0.35	Dolomite
15,440	2.84	22	0.38	Dolomite
15,462	2.84	16	0.26	Dolomite
15,485	2.80	31	0.61	Dolomite
15,522a	2.83	19	0.23	Dolomite
15,522b	2.83	21	0.23	Dolomite
15,555	2.83	25	0.24	Dolomite
15,593	2.85	18	0.32	Dolomite
15,639	2.84	16	0.31	Dolomite
15,679	2.85	34	0.43	Dolomite
15,702	2.86	16	0.25	Dolomite
15,729	2.83	17	0.37	Dolomite
15,756	2.86	32	0.47	Dolomite
15,791	2.85	17	0.38	Dolomite
15,819	2.85	15	0.28	Dolomite
15,183	2.84	30	0.33	Dolomite
15,145	2.83	35	0.28	Dolomite
15,851	2.83	28	0.28	Dolomite
15,885	2.84	16	0.40	Dolomite
15,918	2.77	16	0.70	Dolomite
15,955	2.84	33	0.45	Dolomite
15,983	2.84	26	0.80	Dolomite
16,016	2.83	15	0.41	Dolomite
16,048	2.84	22	0.23	Dolomite
16,071	2.80	14	0.40	Dolomite
16,098	2.81	43	1.15	Dolomite
16,129	2.84	23	0.20	Dolomite
16,166	2.83	15	0.53	Dolomite
16,197	2.84	15	0.40	Dolomite
16,235	2.86	58	0.47	Dolomite
16,263	2.85	16	0.45	Dolomite
16,292	2.85	14	0.26	Dolomite
16,316	2.85	20	0.48	Dolomite
16,341	2.85	83	0.49	Dolomite
		Humble Oil & Refining Company No. D-1 Alma Cox, Crockett County		
7,416a	2.72	14	0.23	Limestone (pebble)

Depth in Feet	Density	Susceptibility per $cm^3 \times 10^{-6}$ (Electromagnetic cgs Units)	*Fe_2O_3 in percent	Rock Type
7,416b	2.72	9.3	0.45	Limestone (entire core)
7,456	2.71	11	0.93	Dolomite
7,543	2.67	9.5	0.42	Dolomite
7,561	2.69	9.7	0.31	Dolomite
7,580	2.73	14	0.59	Dolomite
7,600	2.82	10	0.28	Limestone
7,635a	2.72	11	0.58	Limestone (veined)
7,635b	2.72	11	0.09	Limestone (not veined)
7,654	2.71	11	0.10	Limestone
7,672	2.71	9.8	0.065	Limestone
7,690	2.71	10	0.095	Limestone
7,703	2.65	3.2	0.36	Chert & Limestone
7,710	2.81	15	0.30	Dolomite
7,730	2.73	16	0.10	Limestone
7,750	2.72	15	0.13	Limestone
7,770	2.64	15	0.12	Limestone
7,790	2.79	17	0.29	Dolomite
7,810	2.85	16	0.38	Dolomite
7,819	2.73	22	0.25	Chert
7,830	2.79	17	0.22	Dolomite
7,835	2.71	3.6	0.08	Chert & Dolomite
7,851	2.82	17	0.21	Dolomite
7,870a	2.82	18	0.70	Dolomite (not veined)
7,870b	2.82	17	0.52	Dolomite (veined)
7,890	2.78	18	0.23	Dolomite
7.910	2.78	11	0.25	Dolomite
7,930	2.63	15	0.26	Dolomite
7,950	2.76	10	0.24	Dolomite
7.958	2.59	13	0.14	Chert
7,968	2.76	14	0.18	Dolomite
7.984	2.80	15	0.17	Dolomite
8,000	2.80	11	0.26	Dolomite

Fig. 1 shows the relationship of susceptibility to depth for both wells using the contact between the Ellenburger and Simpson groups as a datum. No correlation has been made within the Ellenburger group; consequently the comparable portions of the curves are unknown, but the curves may be nearly in correct position as shown.

The curves are inclined in opposed directions, the amount of susceptibility is markedly different for the two wells, and the values fluctuate rather widely from sample to sample. Spot sampling, therefore, has not given results that

can be used for subdividing the pre-Simpson rocks. It is possible, however, that continuous logging of magnetic susceptibility in wells might reveal characteristic patterns that can be recognized from well to well, as suggested by Broding, Zimmerman, Somers, Wilhelm and Stripling.[3]

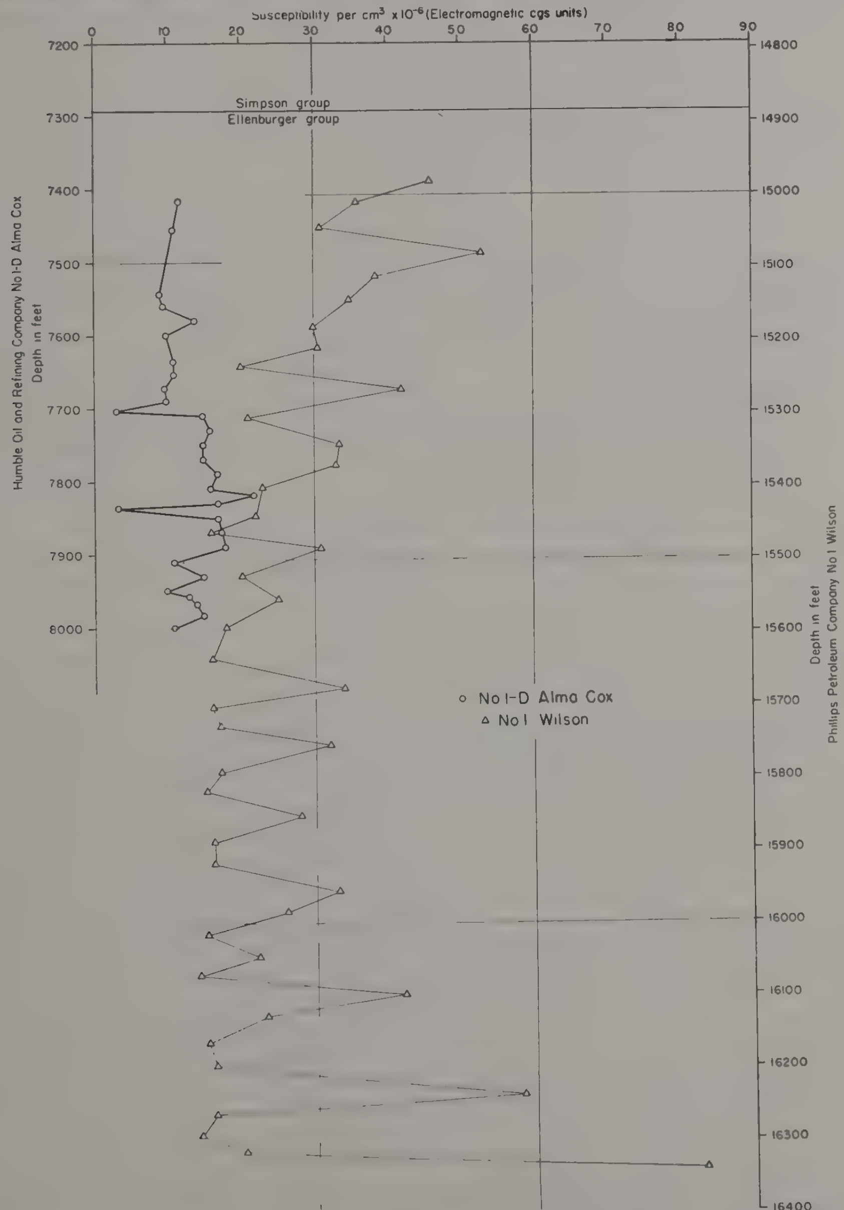


Fig. 1. Relationship of depth to magnetic susceptibility for Phillips Petroleum Company No. 1 Wilson well, Val Verde County, and Humble Oil and Refining Company No. D-1 Alma Cox Well, Crockett County, Texas.

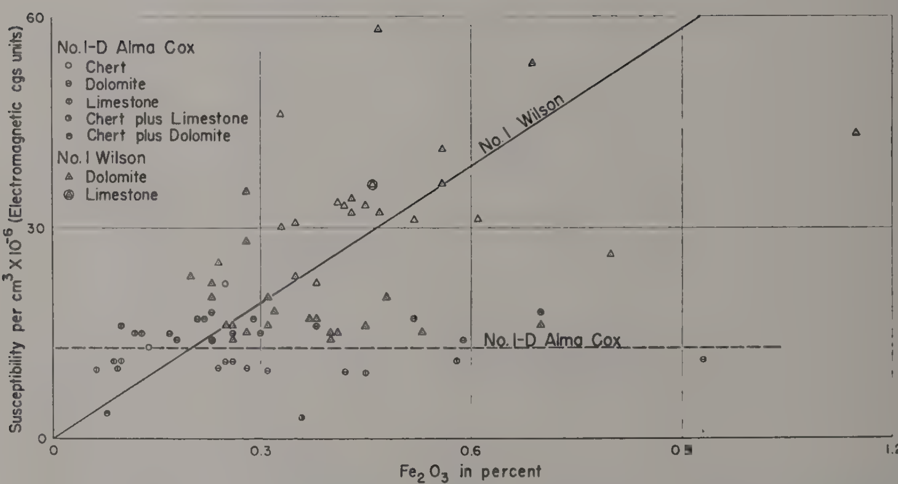


Fig. 2. Relationship of Fe_2O_3 content to magnetic susceptibility for Phillips Petroleum Company No. 1 Wilson well, Val Verde County, and Humble Oil and Refining Company No. D-1 Alma Cox well, Crockett County, Texas.

In figure 2 the relationship of susceptibility to iron content stated as Fe_2O_3 is shown. For the No. D-1 Alma Cox, the susceptibility is about the same no matter how high the iron content, and for the No. 1 Wilson the susceptibility tends to be higher the higher the iron content, but the points are widely scattered in a fan-shaped area. Some of the scattering is probably from inaccurate determination of iron as spectrographic analyses have large error.

Pyrite is the only readily recognized iron-bearing mineral in these cores and it is much more abundant in those from the No. 1 Wilson well than in those from the No. D-1 Alma Cox well, and this may account for the lower susceptibility of the cores from the latter well. In the No. D-1 Alma Cox well the cores which are estimated to have the highest pyrite content also have the highest susceptibility.

Some of the iron in these cores is probably in dolomite as magnesiodolomite and ferrodolomite are isomorphous in all proportions. The dolomite in the No. D-1 Alma Cox cores is mostly somewhat browner than that in the No. 1 Wilson cores suggesting that the former is richer in iron. Brownish clay-like material may also contain some iron.

The mineral or minerals causing magnetic susceptibility in carbonate rocks should be positively identified. From the present work it can only be surmised that pyrite is responsible for most of it and that iron in the dolomite and elsewhere has little effect.

MAGNETIC SUSCEPTIBILITY MEASUREMENTS IN WEST TEXAS AND SOUTHEAST NEW MEXICO[1]

PETER T. FLAWN
Bureau of Economic Geology
The University of Texas

In 1951, The University of Texas Bureau of Economic Geology, with cooperation of a number of oil companies, began a study of subsurface pre-Cambrian rocks in Texas and southeast New Mexico. As a part of this essentially petrographic and structural study of "the basement," magnetic susceptibility of some 96 samples of pre-Cambrian cores and cuttings was measured with the Frost magnetic susceptibility bridge. The writer is indebted to the Frost Geophysical Corporation and Frost Airborne Surveys, Incorporated, for loan of the equipment and for many valuable suggestions.

The results of this study are, in brief, presented in Tables 1 and 2.[2] From these data the following conclusions are presented: (1) Susceptibility values given in Table 1 show a very wide range for common rock types with considerable overlaping of maximum and minimum values. An "average susceptibility" for a particular rock type is probably meaningless.

(2) Generalizations about the susceptibility of a concealed rock body on the basis of samples from a small number of wells are extremely vulnerable in the light of the wide range in susceptibility values for a particular rock type.

[1]Published with permission of the Director, Bureau of Economic Geology, The University of Texas.
[2]Complete text of this paper will appear in a forthcoming Bureau of Economic Geology report on basement rocks in Texas and southeast New Mexico.

TABLE 1. MEASURED MAGNETIC SUSCEPTIBILITY VALUES[1]
all x 10^{-6} cgs units/unit volume

Granite[2]		Granodiorite		Quartz Syenite and Syenite		Quartz Diorite and Diorite		Gabbro		Basalt and Diabase		Rhyolite and Rhyolite Porphyry		Miscellaneous Rocks		
(1)	21	(28)	40	(42)	37	(47)	51	(55)	220*	(63)	80	(69)	18	(82)	andesite porphyry	68
(2)	25	(29)	49	(43)	58	(48)	74	(56)	1200*	(64)	110	(70)	20	(83)	andesite porphyry	4500
(3)	27	(30)	69	(44)	1300	(49)	110	(57)	1600	(65)	340	(71)	26	(84)	andesite tuff	9100
(4)	29	(31)	88	(45)	4600	(50)	130	(58)	1900	(66)	1700	(72)	33	(85)	latite tuff	51
(5)	31	(32)	730*			(51)	150	(59)	2200	(67)	3300	(73)	40	(86)	serpentinite	3200
(6)	32	(33)	750*	**Syenogabbro**		(52)	1400	(60)	2300	(68)	3900	(74)	51	(87)	sericite phyllite	44
(7)	32	(34)	790	(46)	170	(53)	1700*	(61)	2400			(75)	53*	(88)	sericite phyllite	53
(8)	33*	(35)	960			(54)	2200	(62)	6900*			(76)	60	(89)	sericite phyllite	57
(9)	34	(36)	1300									(77)	66	(90)	metaquartzite	67
(10)	37	(37)	1300*									(78)	67	(91)	meta-arkose	72
(11)	43	(38)	3500*									(79)	69	(92)	amphibolite	3200
(12)	67	(39)	4000									(80)	72	(93)	amphibolite	13000*
(13)	180	(40)	4800											(94)	biotite-microcline-oligoclase gneiss	6500
(14)	180											**Rhyolite tuff**				
(15)	250*	**Granodiorite gneiss**										(81)	44	(95)	quartz-hornblende-plagioclase gneiss	52
(16)	250*	(41)	9000											(96)	epidote-hornblende-biotite schist	430
(17)	610															
(18)	670															
(19)	750															
(20)	870															
(21)	950															
(22)	1200															
(23)	1300															
(24)	1400															
Granite gneiss																
(25)	30															
(26)	43															
Mylonitized granite																
(27)	290															

[1]Parenthesized number preceding susceptibility value refers to well name in Table 2.
[2]Rock family names include fine-grained equivalents such as microgranite and microgranite porphyry, microgabbro, etc.
*Sample is cuttings; all others are core samples.

TABLE 2. KEY TO SAMPLE NUMBERS IN TABLE 1.[1]

COUNTY AND STATE	OPERATOR AND FARM	DEPTH AND NATURE OF SAMPLE
(1) Roosevelt, N. M.	Spartan, 1-36 State	core 7140
(2) Lea, N. M.	Humble, 6-V State	core 7705
(3) Andrews, Texas	Phillips, 58 University	core 7922-26
(4) Chaves, N. M.	Franklin, Aston & Fair, 1 Orchard Park	core 5814-27
(5) Lea, N. M.	Amerada, 1 State BTB	core ?
(6) Chaves, N. M.	Gulf, 1 Jennings	core 8300
(7) Lea N. M.	Olson & Atlantic, 1 Langlie	core 9584
(8) Sutton, Texas	Shell, 3 Core Test (Miers)	cuttings 4950-5003
(9) Chaves, N. M.	Gulf, 1 Jennings	core 8319
(10) Pecos, Texas	Humble, 1 Wilson	core 5235
(11) Lea, N. M.	Continental, 1 Burger B-28	core 9379
(12) Mitchell, Texas	Sun, 2 Elwood	core 8520-24
(13) Pecos, Texas	McCandless, 1 University	core 5513
(14) Lea, N. M.	Gulf, 2 Stitcher	core 7980
(15) Lea, N. M.	Amerada, 6 Corrigan	cuttings 7687
(16) Lea, N. M.	Amerada, 7 Phillips	cuttings 10211
(17) Debaca, N. M.	Pure, 1 Federal-Fee	core 6467
(18) Presidio, Texas	Welch, 1 Espy	core 7830
(19) Chaves, N. M.	Humble, 1 Federal-Gorman	core 5848-49
(20) Lea, N. M.	Gulf, 7 King	core 8051-60
(21) Lubbock, Texas	Magnolia, 1 Johnson	core 10171-78
(22) Lubbock, Texas	Magnolia, 1 Johnson	core 10171-78
(23) Lea, N. M.	Stanolind, 11-X State	core 8150
(24) Chaves, N. M.	Honolulu, 1 Federal-Hinkle	core 7310-15
(25) Lea, N. M.	Sinclair, 2 State 367	core 7642-46
(26) Mitchell, Texas	Sun, 2 Elwood	core 8464-74
(27) Roosevelt, N. M.	Tidewater, 1 Best	core 7265-77
(28) Lea, N. M.	Magnolia, 17 E. O. Carson	core ?
(29) Lea, N. M.	Continental, 1-E Lockhart A-27	core 7791
(30) Lea, N. M.	Gulf, 5-F Graham-State	core 9820
(31) Crane, Texas	Atlantic, 2-A University	core 11642-45
(32) Lea, N. M.	Amerada, 3-A Phillips	cuttings 11006
(33) Lea, N. M.	Cities Service, 3-S State	cuttings 8030-34
(34) Chaves, N. M.	Richfield, 1 Mullis	core 12143-53
(35) Gaines, Texas	Texas, 1 Jenkins	core 11699
(36) Lea, N. M.	Continental, 2 Warren B-29	core 9850-52
(37) Lea, N. M.	Shell, 1 Chesher	cuttings 7630-65
(38) Lea, N. M.	Amerada, 5 Corrigan	cuttings 7803
(39) Lea, N. M.	Humble, 1 Federal-Keinath	core 9951-54
(40) Lea, N. M.	Continental, 1 Warren A-29	core 9361-91
(41) Chaves, N. M.	Magnolia, 1 Federal-Turney	core 5321-24
(42) Pecos, Texas	Magnolia, 3 Fromme	core 4667-82
(43) Pecos, Texas	Magnolia, 3 Fromme	core 4682-97
(44) Lea, N. M.	Sinclair, 1 Barton	core 7786
(45) Lea, N. M.	Gulf, 5-A J. N. Carson	core 7881
(46) Otero, N. M.	Standard Texas. 1 Sp. Unit	core 2644-60
(47) Scurry, Texas	Sun & Ohio, 1 Helms	core ?
(48) Lea, N. M.	Continental, 1 Burger B-28	core 9373
(49) Andrews, Texas	Humble, 1 Scarborough	core 10926-29
(50) Roosevelt, N. M.	Spartan, 1-36 State	core 7210
(51) Lea, N. M.	Continental, 1 Burger B-28	core 9376
(52) Donley, Texas	Stanolind, 1 Broome	core 6748-53
(53) Eddy, N. M.	Continental, 1 Federal-Thurman	cuttings 10760-65

[1] Samples are grouped by rock type in Table 1. Table 2 may list the same well and core interval more than once, but each listing represents a diffrent susceptibility value in Table 1.

TABLE 2—(Continued)

	COUNTY AND STATE	OPERATOR AND FARM	DEPTH AND NATURE OF SAMPLE
(54)	Chaves, N. M.	Honolulu, 1 Federal-Hinkle	core 7310-15
(55)	Otero, N. M.	Standard Texas, 1 Sp. Unit	cuttings 2592-97
(56)	Lincoln, N. M.	Standard Texas, 1 Federal-Heard	cuttings 7800-70
(57)	Bailey, Texas	El Paso Nat. Gas, 1 W. Tex. Mtge-Loan	core ?
(58)	Lincoln, N. M.	Standard Texas, 1 Federal-Heard	core 8050
(59)	Hale, Texas	Amerada, 1 Kurfees	core 10245-50
(60)	Lea, N. M.	Continental, 1 Warren A-29	core 9371-72
(61)	Castro, Texas	Sun, 1 Herring	core 10449-54
(62)	Pecos, Texas	Union Cal., 1-C Heiner	cuttings 6155-60
(63)	Chaves, N. M.	*Humble, 1-N State	core 3804-09
(64)	Roosevelt, N. M.	Mid-Continent, 1 Strickland	core 7508-13
(65)	Chaves, N. M.	*Humble, 1-N State	core 3804-09
(66)	Chaves, N. M.	Barnsdall, 1-A State	core 12034-40
(67)	Swisher, Texas	Standard Texas, 1 Johnson	core 9193-9200
(68)	Chaves, N. M.	*Humble, 1-N State	core 3500-03
(69)	Lea, N. M.	Amerada, 1 State BTA	core 11754-55
(70)	Lea, N. M.	Amerada, 1 State BTA	core 11716
(71)	Cochran, Texas	Humble, 1 Westheimer	core 7393-94
(72)	Armstrong, Texas	Standard Texas, 1-A Palm	core 6140-41
(73)	Yoakum, Texas	Continental, 1 Rodgers	core 13015
(74)	Hockley, Texas	Humble, 1 Hobgood	core 10174
(75)	Childress, Texas	Stanolind, 1 Owens	cuttings 7381-84
(76)	Cochran, Texas	Humble, 1 Masten	core 10788
(77)	Cochran, Texas	Stanolind, 1 Reed	core 12678
(78)	Lubbock, Texas	Humble, 1 Farris	core 11780
(79)	Otero, N. M.	Hunt & Turner, 1 McMillan	core 2175
(80)	Hockley, Texas	Honolulu & Sunray, 1 Moore	core 11304-05
(81)	Yoakum, Texas	Continental, 1 Rodgers	core 13016
(82)	Chaves, N. M.	Sun, 1 Pinion	core 1850
(83)	Lamb, Texas	Stanolind, 1 Hopping	core 9606-14
(84)	Lamb, Texas	Stanolind, 1 Hopping	core 9600-24
(85)	Yoakum, Texas	Continental, 1 Rodgers	core 13015
(86)	Castro, Texas	Sun, 1 Herring	core 10114-28
(87)	Motley, Texas	Humble, 2-H Matador	core 7878-82
(88)	Chaves, N. M.	Olson, 1 Noble Trust	core 7630-60
(89)	Chaves, N. M.	Olson, 1 Noble Trust	core 8030 ?
(90)	Eddy, N. M.	Humble, 1 Pearson	core 8243-48
(91)	Eddy, N. M.	Humble, 1 Pearson	core 8243-48
(92)	Roosevelt, N. M.	Austral, 1 Saddler	core 8130-56
(93)	Pecos, Texas	Stanolind, 1-A Hinyard	cuttings 6700-05
(94)	Pecos, Texas	Humble, 1-L University	core 5630-40
(95)	Roosevelt, N. M.	Spartan, 1-36 State	core 7204
(96)	Debaca, N. M.	South Basin, 1 Good	core 4774-79

*May be younger than pre-Cambrian.

A BIBLIOGRAPHY OF PAPERS HAVING EXPERIMENTAL DATA ON THE MAGNETIC SUSCEPTIBILITY OF MINERALS AND ROCKS [1]

HAROLD M. MOONEY [2]

*Bersudskii, L. D., "Magnetic Properties of Rocks as Determined by Their Content of Ferromagnetic Substances". (In Russian). Tsent. Nauch-Issl. Geol. Razy. Inst. Geof. *13* (1948), p. 85-97. (Geoph. Abstr. 136, #10770). Susceptibility, remanent magnetization, and magnetite content on 77 samples of peridotite.

Bhattacharya, P. K., "An Investigation of Changes in the Magnetic Field of the Earth". Ph.D. Thesis, Calif. Inst. Tech. 1950.
Incidental reference to susceptibility.

*Bishopp, D. W., "Occurrence of Nickel and Magnetite in Some Irish Serpentines, in Conjunction with a Magnetic Survey". Sci. Proc. Royal Dublin Soc. 24 (1943), p. 125-133. Modified Johnson-type rotating sample apparatus, to measure remanent magnetization and susceptibility.

*Bossolasco, M., "Magnetic Susceptibility of Some Minerals of the Magnetite Group". (In Italian). Geofis. Pura e Appl. *12* (1948), p. 53-60. (Geoph. Abstr. 140, #11701). Crude determinations using method of Grenet.

*Bronstein, K. G., "Comparison of the Petrographic Composition of Crystalline Rocks with Their Magnetism". (In Ukranian). Acad. Sci. Ukr. S.S.R., Jour. Geol. *7* (1940), p. 167-178. (Geoph. Abstr. 105, #6008).
Expresses susceptibility as a function of FeO and Fe_2O_3.

Bruckshaw, J. M., and Robertson, E. I., "Measurement of Magnetic Properties of Rocks". Jour. Sci. Inst. *25* (1948), p. 444-446.
Rotate small cubes in a magnetic field.

*Bruckshaw, J. M., and Rao, B. S., "Magnetic Hysteresis of Igneous Rocks". Proc. Phys. Soc. London *63B* (1950), p. 931-938.
Variation of susceptibility with field strength.

Cheneveau, C., "Magnetic Balance of Curie and Cheneveau". Phil. Mag. *20* (1910), p. 357-369.

*Cox, A. H., "Report on Magnetic Disturbances in Northamptonshire and Leicestershire and Relations to Geologic Structure". Phil. Trans. Royal Soc. *219A* (1919), p. 73-135. Data on iron ore susceptibilities.

Curie, P., and Cheneveau, C., "An Apparatus for Determination of Magnetic Constants". (In French). Jour. de Phys. 1903, p. 796-802.
Rough measurements, using the effect on a magnet.

Duffin, R. J., "Measurements of Magnetic Susceptibility with the Hughes Induction Balance". Terr. Magn. Elec. *51* (1946), p. 419-426.
Adaptation of a Model 625 Mine Detector to measurements on rock outcrops.

Fereday, R. A., 'Improved Method for Comparison of Small Magnetic Susceptibilities". Proc. Phys. Soc. London *43* (1931), p. 383-393.
Uses torsion balance and shaped magnetic pole pieces.

*Grenet, G., "Magnetic Properties of Rocks." (In French). Annales de Phys. *13* (1930), p. 268-348. Experimental work uses Curie-Cheneveau balance and Hughes balance. Several pages of data and extensive bibliography.

Grenet, G., "An Apparatus for Determining the Magnetic Properties of Rocks". (In French). Comptes Rendus, Paris *196* (1933), p. 874-875.

Haalck, H., "Rock Magnetism". (In German). Becker und Erler, Leipzig, 1942, 90 pages.

[2] University of Minnesota.
*Includes numerical susceptibility values for particular rock samples.

*Hallimond, A. F., and Herroun, E. F., "Laboratory Determinations of the Magnetic Properties of Certain Igneous Rocks". Proc. Royal Soc. London *141A* (1933), p. 302-314.
Effect of a rotating sample on a permanent magnet.

Herroun, E. F., "Magnetic Properties of Solid and Powdered Magnetites". Proc. Phys. Soc. London *55* (1943), p. 338-343.
Powdering greatly reduces susceptibility.

Herroun, E. F., and Hallimond, A. F., "Laboratory Experiments on the Magnetization of Rocks". Proc. Phys. Soc. London *55* (1943), p. 214-220.
Susceptibility vs. field strength.

*Hoylman, H. W., and Durbin, H. A., "Study of Susceptibility of Sediments". Trans. Amer. Geoph. Union 1944 IV, p. 543-555.
Balanced coil instrument for low susceptibilities.

Hyslop, R. C., "A Field Method for Determining the Magnetic Susceptibility of Rocks". Am. Inst. Min. Eng. Tech. Publ. 1285, 1940. Also Transactions, vol. 164. Calibrated substitution method.

*Jouravasky, G., Charczenko, P., and Choubert, G., "Susceptibility of Some Basic Eruptives". (In French). Comptes Rendus, Paris, *197* (1933), p. 522-525.

Kalashnikov, A. G., "Method for Determining the Magnetic Susceptibility of Rocks in Natural Conditions". (In Russian). Akad. Nauk SSSR Doklady *63*, 6 (1938), p. 657-660. (Geoph. Abstr. 138, 11246).
Four-coil balanced induction instrument.

Kapitza, P., and Webster, W. L., "Method of Measuring Magnetic Susceptibilities". Proc. Royal Soc. London *132* (1931), p. 442-459.
Effect on permanent magnet.

*Kato, Y., "Investigation of the Magnetic Properties of the Rocks Constituting the Earth's Crust. On the Susceptibility of the Rock". Tohoku Imp. Univ. Sci. Repts. *29*, 4 (1941) p. 602-648.

Koenigsberger, J. G., "On Magnetic Properties of Rocks". (In German) Terr. Magn. Elec. *35* (1930), p. 145-148.

Ibid "Magnetic Properties of Ferromagnetic Minerals in Rocks." (In German). Beitr. Ang. Geoph *4* (1934) p. 385-394.

*Ibid "Magnetic Susceptibility of Rocks from the Swiss Central Alps and the Areal Susceptibility of the Region from Fluelen to Bellinzona". (In German). Schweiz. Min. Pet. Mitt *16* (1936), p. 209-214.

Koenigsberger, J. G., "Natural Residual Magnetism of Eruptive Rocks". Terr. Magn. Elec. *43* (1938), p. 119-130 and 299-320.
Summary of recent work with extensive bibliography.

*Marsch, B., and Schoene, H. J., "Report on Measurements of Magnetic Susceptibility". (In German). Beitr. Ang. Geoph. *8* (1940), p. 195-200.
Balanced coil system. Conclude effect of pulvertization of sample can be neglected.

*Mooney, H. M., "Magnetic Susceptibility Measurements in Minnesota. Part I: Technique of Measurements". Geophysics *17* (1952) p. 531-543.

Mooney, H. M., "An Instrument for Measuring Rock Magnetism". Electronics (in press. Probably May, 1953).

*Mooney, H. M., and Bleifuss, Rodney, "Magnetic Susceptibility Measurements in Minnesota. Part II: Analysis of Field Results". Geophysics *18* (1953), p. 383.

*Morley, L. W., "Correlation of Susceptibility and Remanent Magnetism with the Petrology of Rocks from Some Precambrian Areas in Ontario". Ph.D. Thesis, Univ. Toronto, 1952.

*Nagata, T., "Some Physical Properties of the Lavas of the Volcanoes Asama and Mihara. II: Magnetic Susceptibility". Bull. Earthquake Res. Inst. Tokyo *18* (1940), p. 102-134. Ballistic and balanced coil methods. Chemical analysis for normative magnetite.

Nagata, T., 'Measurement of Changes in Magnetic Susceptibility of Igneous Rocks with Temperature in a Weak Magnetic Field". Bull. Earthquake Res. Inst. Tokyo *19* (1941), p. 579-596.

*Nagata, T., "The Natural Remanent Magnetism of Volcanic Rocks and Its Relation to Geomagnetic Phenomena". Bull. Earthquake Res. Inst. Tokyo *21* (1943), p. 1-197. Extends Ollendorf's dust-core formula for susceptibility to include external and internal demagnetization. Measures susceptibility vs. magnetite content and field strength.

Nettleton, L. L., and Elkins, T. A., "Association of Magnetic and Density Contrasts with Igneous Rock Classifications". Geophysics *9* (1944), p. 60-78.

Petrova, G. N., "Investigation of Powdered Magnetites". (In Russian). Akad Nauk SSSR Izv. Ser. Geog. i Geofiz. *12* (1948), p. 549-556. (Geoph. Abstr. 137, #11032). Effect of magnetite concentration and grain size on demagnetization factor.

Puzicha, K., "Magnetic Properties of Eruptive Rocks". (In German). Zeits. Prakt. Geol. 38 (1930), p. 161-172 and 184-189.

*Ibid "Magnetism of Rocks as a Function of Magnetite Content". (In German). Beitr. Ang. Geoph. *9* (1941), p. 158-186.
Ballistic method. Classifies rocks based on susceptibility variation with field strength. Measures demagnetization factor.

Rankine, A. O., "Simple Method of Demonstrating Para- and Dia-magnetism of Substances in Magnetic Fields of Low Intensity". Proc. Phys. Soc. London *46* (1934), p. 391-407. Torsion balance, 50 oersted field.

*Reich, H., "Magnetic Properties of Rocks and Ores". (In German). Zeits. Deutsch. Geol. Gesells. *93* (1941), p. 443-455.
Remanent vs. induced magnetism of well cores.

*Reich, H., "Natural Magnetization of Rocks on the Basis of Measurements in Boreholes". (In German). Beitr. Ang. Geoph. *9* (1941), p. 40-64.

*Seeds, W. E., and Poole, J. H. J., "Magnetic Properties of the Serpentine Deposits in the Slishwood Gap, County Sligo, Ireland". Scient. Proc. Royal Dublin Soc. *24* (1945), p. 135-149. Supplements paper by Bishop.

*Slichter, L. B., "Certain Aspects of Magnetic Surveying". Am. Inst. Min. Met. Eng. Geoph. Prosp. 1929, p. 238-260.
Concludes pulverization strongly reduces susceptibility.

*Tagaki, H., "On the Susceptibility of Soils and Sands". Sci. Rpts. Tohoku Imp. Univ. Ser. 1, vol. 2 (1913), p. 15-24. Fields of 1000 oersteds.

Ting, S. L., and Chen, C. C., "A Simple Substitution Method for the Determination of the Magnetic Susceptibility of Mineral Rocks. Jour. Chinese Geoph. Soc. 2 (1950), p. 60-65.

*Turcev, A., Investigation of the Magnetic Properties of Rocks". (In Russian). Akad. Nauk Izvest. Ser. 7 (1928), p. 89-112.

*Turtzev, A. A., "Magnetic Properties of Brown Iron Ores of the Kerch Peninsula". (In Russian). Trudy Inst. Geol. Nauk, Akad. Sci. USSR *21*, 7 (1940), p. 23-28. (Geoph. Abstr. 103, #5773).
Unsuccessful attempt to correlate Mn with susceptibility.

Wang, Tsu Chang, "A Simple Method of Determining the Magnetic Susceptibility of Rocks in Weak Fields". Zeits. Geoph. 1940, ¾, p. 160. (In German).
Torsion balance method. Includes extensive review of previous work.

*Werner, S., "Determinations of the Magnetic Susceptibility of Ores and Rocks from Swedish Iron Ore Deposits". Sver. Geol. Unders. 39, 5 (1945), 79 pages.

Joseph Audley Sharpe
1907 - 1952

MEMORIAL BIOGRAPHY

This particular volume is published by the Geophysical Society of Tulsa as a memorial to Dr. Joseph Audley Sharpe, editor of **Geophysics** from 1942 to 1945, a member of the Society of Exploration Geophysicists since 1935, and a charter member of the Tulsa Society. His sudden death from a heart attack on the night of May 9, 1952, came as a shock and personal loss to all who had had the pleasure of knowing him.

There are many scientists whom one sincerely appreciates for their professional accomplishments. Others we recall for their ability to analyze knotty problems, or for their success as managers or administrators. It is a rare and pleasant experience to be able to say: There went a man who was a success as a man. Dr. J. A. Sharpe was internationally known for his work in seismology, and as an authority on geophysical prospecting. Joe Sharpe was known as a warm-hearted person who would share your triumphs and your troubles over interminable cups of coffee and countless cigarettes, whose help and service were as ready as his wit was keen.

I had the good fortune to study engineering physics from Joe at the University of Arizona in 1930, where his humility, broad understanding, and informality made him an immediate friend of a bewildered class. From Arizona he went to Wisconsin, obtaining his Ph.D. in geophysics under Max Mason in 1934. After a year's post doctorate at M.I.T., where he held a Rockefeller Foundation Fellowship, he joined the research laboratories of Western Geophysical Co. in Los Angeles in 1935.

His early research work concerned the then little-known field of study of generation and propagation of explosive waves near the source. A favorite story for years was of the stormy trip on the Pacific in a small cabin cruiser with Sharpe, empty and green, still grimly hanging onto caps, explosive, and the "dead man" switch until we got him his precious records.

His subsequent career is well-known through his publications and society affiliations. He joined Stanolind's research laboratory in 1938, where he was in charge of exploration research for two years, relinquishing administration to pursue more intensively special problems in seismic prospecting. He became Executive Vice President of Frost Geophysical Corporation in 1945, and President of the associated Geophysical Development Corporation, both posts terminated by his untimely death. During these years he devoted much time to the development of airborne magnetometer equipment and the interpretation of gravimetric and magnetic data.

Geophysicists have lost a brilliant member of the profession. His family lost a devoted father (sadly enough, his wife Cecile survived him only a little over a year), and his wide list of friends, an understanding and unobstrusive source of strength.

Paul F. Hawley

ABSTRACTS OF PAPERS AND LECTURES GIVEN BEFORE THE GEOPHYSICAL SOCIETY OF TULSA

THE NEED FOR QUANTITY AND QUALITY IN VELOCITY SURVEYS

Oct. 9, 1953

Petroleum Science Hall, University of Tulsa

The meeting took the form of a symposium. Dr. L. Y. Faust[1] acted as moderator. Papers by B. G. Swan[2], Robert C. Kendall[3], Neil B. Sparks[4], John E. Owen[5], Francis H. Cady[6] and Paul L. Lyons[7] discussed respectively the following topics:

1. Why the symposium was held—Faust.
2. How to make effective use of velocity survey data—Swan.
3. How to improve survey accuracy—Kendall.
4. How to improve quality of first breaks—Sparks.
5. Time measurement problems—Owen.
6. How much control is needed—Cady.
7. Value of velocity surveys.—Lyons.

The papers with illustrations but without discussion from the floor were published in the March 30, 1953, number of the Oil and Gas Journal, Tulsa, pages 119-137.

[1] Amerada Petroleum Corp.
[2] Continental Oil Co.
[3] Shell Oil Co.
[4] Stanolind Oil & Gas Co.
[5] Geophysical Research Corp.
[6] The Carter Oil Co.
[7] Anchor Petroleum Co.

OFFSHORE EXPLORATION OPERATIONS ON THE PACIFIC COAST

CURTIS H. JOHNSON*

Oct. 21, 1953

Petroleum Science Hall, University of Tulsa

At this extra meeting, Mr. Johnson gave a most interesting illustrated talk describing marine exploration along the coast of southern California.

* General Petroleum Corporation, California.

WAVELET CONTRACTION, WAVELET EXPANSION, AND THE CONTROL OF SEISMIC RESOLUTION*

NORMAN RICKER †

Nov. 6, 1953

Petroleum Science Hall, University of Tulsa

This paper describes a practical application of the author's Wavelet Theory of Seismogram Structure to the problem of seismic resolution and its control.

The importance of knowing the form and nature of the primary seismic disturbance in a homogeneous and isotropic earth is brought out, and it is shown how the theory may be extended to include a layered earth. With seismic apparatus which does not in itself introduce distortions the seismogram consists of numerous overlapping wavelet forms. Such a seismogram is an elaborate wavelet-complex. Studies of seismic resolution of simple two-wavelet complexes are given and equations are set down enabling an answer to be given to the question: "How far apart do two reflecting interfaces have to be in order that they may be mapped as separate beds?"

The distortions introduced by conventional seismographs are discussed and it is shown that conventional amplifiers deliver a complicated and prolonged output disturbance when a single simple wavelet form is introduced at the input.

The conditions to be imposed upon seismic apparatus in order to reproduce a seismic wavelet without distortion are set down, with respect to both phase and amplitude response characteristics, and it is shown that three types of distortion-free seismographs are possible; flat response, the wavelet contractor, and the wavelet expander.

The effect of wavelet contraction upon the resolution of wavelet complexes is discussed and it is shown that by a suitable choice of response characteristics the individual wavelets which go to make up a seismogram may be contracted to a lesser breadth without altering the relatives arrival times of the wavelet centers, resulting in the resolution of wavelet complexes otherwise not resolved. Laboratory studies of the resolution of such wavelet complexes by the wavelet contractor are discussed and illustrated, and a description of a field seismograph embodying the principle of wavelet contraction is given. The performance of this wavelet-contracting seismograph in a field evaluation program is described.

The wavelet contractor is able to determine depths more precisely than is the conventional seismograph and is able to carry pinchouts and truncations to a greater distance than is possible with the conventional seismograph. However, the wavelet contractor is a special purpose instrument and is of value only in areas where reflections are good by ordinary standards.

The wavelet expander also is discussed, whereby the wavelets which go to make up a seismogram are expanded without altering the relative arrival times of the wavelet centers. With the wavelet expander overlapping of the wavelets is increased, resulting in a deliberate loss in resolution. Possible areas in which the wavelet expander may be of service are suggested.

---

*Presented before the Geophysical Society of Tulsa, November 6, 1952.

†Senior Research Physicist, The Carter Oil Company, Tulsa, Oklahoma.

THE ORIGIN OF CONTOINENTS AS DEDUCED FROM GEOLOGICAL AND GEOPHYSICAL EVIDENCE

J. Tuzo Wilson*

Nov. 19, 1952

Kendall Hall, University of Tulsa

Most Precambrian rocks and many later metamorphic rocks are often grouped together and regarded as the "Basement." As they are without appreciable oil and contain few fossils the interest of petroleum geologists in these rocks has been slight and indirect. On the other hand they are important to mining geologists and to those concerned with the fundamentals of continental structure, but even for them the basement rocks have proved difficult to decipher.

Today the accumulated results of detailed mapping in many Precambrian areas together with new age determinations are gradually leading to a clearer understanding of Precambrian history and these new ideas are such that they may have a considerable impact upon the whole of geological thinking. It is too early to be dogmatic but some of the trends are worth noting.

In the first place there appear to be Precambrian rocks still present on several continents of all ages up to 3 billion or more ($3x10^{*}$) years old. As that age is six times that usually accepted for the beginning of the Paleozoic era it can be understood that there was plent yof time for the comparatively complex animals of the Cambrian period to have evolved before the development of hard parts led to the preservation of the first fossils.

The discovery of the length of this great period and the establishing of dates within it also suggests that the usual views about Precambrian time have been altogether too simple. Not only are there metamorphic rocks of every age from the Cenozoic back to the most ancient, but there are also flat-lying and comparatively little altered rocks at least three times as old as the Cambrian. As C. K. Leith suggested twenty-years ago the terms Archean and Proterozoic should properly be used to refer to types of rocks not periods of time.

When the metamorphic rocks of Archean type are considered alone, it is found that they can be subdivided into provinces by means of both structure and age determinations. The boundaries between these provinces in some places have been found to be great faults. The provinces are marked by differences in petrology and in patterns of foliation. More recently it has been found that all the pegmatites which have been dated for each of these same provinces have ages that fall within a definit eperiod of time which is different and characteristic for each province.

The pattern which is emerging is similar in all continents but is not one that had been anticipated. In all cases the oldest rocks lie in the central parts of the continents or at least away from the margins. These are always provinces

* University of Toronto, Canada.
This was a special meeting for the distinguished lecturer of the Society of Exploration Geophysicists.

marked by pegmatites and presumably intrusives more than two billion years old. All of these oldest groups of rocks consists, as Gill has pointed out, of predominantly volcanic rocks of the Keewatin type cut by large areas of granite and gneisses.

With them are undifferentiated sediments lacking pure quartzites, limestones and arkoses but consisting chiefly of poorly sorted fragments of volcanic rocks. These assemblages of lavas suggest that the temperature gradient within the earth was then greater, leading to easier melting, and that there then existed no older granitic blocks from which differentiated sediments could be derived. In other words it suggests that the continents began as belts of volcanoes, but the early history was also clearly much disturbed.

Surrounding these nuclei on all sides are broad strips of gneissic rocks in which all age determinations are less than two billion years old. These gneissic provinces contain a lower proportion of volcanic rocks and they have remnants of normal differentiated sediments. They can be distinguished one from another partly by structural studies and partly by age determinations, for each province has been found to have pegmatites in it which are all from the same limited period of time. These periods are each about three or four hundred million years which while long absolutely are short relative to the whole span of geological time. Where two of these provinces intersect or lie one beyond the other it is found that the younger always lies towards the margin of the continent.

One example which may clarify the general arrangement is provided in eastern North America. There the old nucleus of the Keewatin province with an age greater than two billion years covers most of northern Ontario and extends into Quebec. Southeast of it along the north shore of the Saint Lawrence River from Lake Huron to Labrador lies a broad strip of Grenville gneisses from many of whose pegmatites age determinations have been made. All of these are between eleven and eight hundred million years old. The fact that some veins but no pegmatites are younger is of no great consequence but the fact that no age determinations in this province are older is held to be significant.

Farther southeast beyond what is commonly called the Canadian Shield but still within the continental block lie the Appalachian mountains. They consist of a strip of gneisses and folded rocks similar in shape and size to the Grenville province but the ages of all pegmatites in the Appalachians lie in the range six to two hundred million years ago.

Beyond the Appalachians lies the Atlantic Coastal Plain of which the rocks, in this case entirely sedimentary, have all been laid down within the last two hundred million years.

This arrangement, which is characteristic of that found in all places so far investigated, suggests, that just as the Appalachian province is or was a mountain range, so was the Grenville province once a mountain range (as Adams and Barlow suggested in 1910) and so was the Keewatin, although the Keewatin may very well be a complex of several old periods of folding. The continent appears to have been growing. A century ago Dana suggested marginal accretion but the increased length of geological time now allows for complete growth of the continents.

We can see that complete growth within geological time is likely for another reason. The continental blocks are known to be about fifty million square miles in area and about twenty miles thick, that is about one billion cubic miles in total volume.

Such masses could have been generated during geological time by additions at the earth's surface of granitic or granodioritic material at the average rate of one third of a cubic mile per year.

Now Ewing has recently shown that the floors of both the Caribbean Sea and the Atlantic Ocean are of basalt and ultrabasic rocks without a granitic layer. Nevertheless it is upon that floor that active acid volcanoes are building the West Indies and hence their lavas must be coming from greater depths and must be adding to the total acid rock material at the surface. The rate of these additions is not known there, but measurements on other volcanoes like Paricutin and Katmai suggest that the earth's 400 active acid and andesitic volcanoes are indeed likely to be contributing new continental material at about the required rate. The question can well be asked why should this state of affairs not have been usual in the past and if it has where have the new accessions of acidic material gone if not to be reworked, granitized and formed into continents? Rubey and Kulp have already suggested that the oceans and the atmosphere were formed from volcanic eruptions in exactly this manner and volcanoes give forth lavas as well as water and gases.

It thus appears that mountain building is the basic earth process and that its elucidation would provide the key to the structure of continents also. Now the earth is an operating heat engine and presumably active mountain belts are the places where the engine is working most strongly today, while continents are the scars of past operations. What is the process or cycle of mountain building? At present only two views are held by any large number of both geologists and physicists. One is that mountains are the result of contraction and fracturing of the earth's crust and the other is that mountains are due to flow of some kind also of thermal origin Granted then that both fracture and flow do sometimes take place which is the primary process?

According to what has just been said mountain building is a cyclical process of which each new cycle starts at the outer side of a continental margin and there grows and forms a mountain range over a period of three or four hundred million years. By that time the new range has become a complete addition to the continent and become inactive as the Appalachian Mountains did in Triassic time. The process then becomes active elsewhere. Later it may return and start a fresh range beyond what is now the new continental margin.

The cycle thus consists in the embryonic state shelf stage like the present Atlantic Coastal plain. The first active stage consists of an island arc like the Aleutians which grows larger by additions of material as it gets older until it resembles Japan. Eardley has pointed out that the addition of more material from the volcanoes and from the erosion of the old continent gradually changes what had been an off-shore arc like Japan into a marginal range like the Cordillera. The active part of the cycle is then complete and the activity moves on elsewhere leaving mountains which have become inactive having

lost their volcanism and seismicity. Such inactive mountains slowly wear down until they become a shield province like the Grenville.

An examination of the physics of such a process has recently been made by Scheidegger in the Bulletin of the Geological Society of America with the conclusion that the only mechanism capable of causing the beautiful arcuate structure characteristic of the early stages is fracture due to contraction. The fracturing, however, allows acidic matter to rise which gradually swamps the early symmetrical pattern until it is lost almost completely.

Flow undoubtedly does take place in rocks and its effects are particularly evident in Archean rocks. So far it has not been possible to give a very satisfactory account of flow as a primary cause of mountain building, so presumably it is a secondary effect due to heating of the near surface rocks by the rise of hot solutions and magmas from deep within the earth. The necessary heating to cause flow in the near-surface rocks apparently only occurs where primary fracture has given access to the depths.

This idea is supported by the observation that away from the actual locus of mountain building the contemporary secondary failure in the crust are fractures. Such fractures include those like the Nemaha uplift which play an important part in the accumulation of oil. Many such fractures like the Nemaha fault or the Attawa-Bonnechere graben of Kay and Alice Wilson are large fractures breaking away from the Appalachian and other mountain ranges. They are pure fractures, yet contemporaneously with them along the axis of the mountain belt there was igneous intrusion and flow as well as fracturing.

An attempt has thus been made to sketch an outline of mountain and continental growth and to give a physical reason for it. The validity or otherwise of these ideas will scarcely effect the work of many field geologists whose concern is with limited areas. Other geologists will point out that this theory runs counter to some ideas which have been expressed about radioactivity, temperatures, isostasy and flow within the earth.

Attempts are being made to answer these difficulties and recent data suggest that this may already be possible in the first three cases while it is admitted in the case of the fourth that flow does take place in the earth's crust under some circumstances, but it is held to be a secondary factor and not the primary cause of mountain building.

A VELOCITY FUNCTION INCLUDING LITHOLOGIC VARIATION

L. Y. Faust[1]

December 11, 1952

Petroleum Science Hall, University of Tulsa

Assuming velocity (V) a function of depth (Z), geologic time (T), and lithology (L) the resistivity log is an approach to the determination of L. Since general knowledge of water resistivity values (R_w) is lacking, the values of true resistivity (R_t) against $V/a(ZT)^{1/6}$ were compared for 670,000 feet of section widely distributed geographically. Variations in R_w were presum-

*Amerada Petroleum Corporation, Tulsa.
This paper was published in **Geophysics** Vol. XVIII No. 2 April 1953, pp. 271-288.

ably averaged out thereby, and the results indicate that statistically $L = [R_t]/T$ and $V = 1948\,(ZTL)^{1/6}$. This formula was applied to an additional 270,000 feet of section more localized geographically to observe its accuracy in predicting vertical travel time. If a correction map for R_w variations is applied the results are encouraging but less accurate than good velocity surveys.

Examination of an inconclusively small amount of data with more careful measurements of R_t suggests that accuracy comparable to direct measurement may be attainable. The cooperation of other investigators and of the electric-logging specialists is desired.

THE ATLANTIC OCEAN BASIN AND ITS MARGIN

MAURICE EWING*

(Distinguished Lecture Tour)

Kendall Hall, University of Tulsa

January 19, 1953

This was a joint meeting with the Tulsa Geological Society.

*Lamont Geological Observatory (Columbia University), N. Y.

AN ANALOGUE COMPUTER FOR STUDYING SEISMIC REFLECTION COMPLEXES

FRANKLIN K. LEVIN*

Feb. 12, 1953

Although in theory the reflection seismogram expected from a given earth section can be predicted if all subsurface conditions are known exactly, in practice the computations are so complex as to be nearly unmanageable by hand methods alone and the aid of a mathematical computer is essential. A computer has been built for this purpose at the Carter Oil Company Research Laboratory: it is an analogue computer called the acoustic analogue or acoustic model. With it, seismic problems involving plane wave pulses incident normally on flat beds, i.e. one dimensional geometry, can be handled by reproducing the pulses and the beds on a scale of a hundred feet of earth to one foot of model.

The acoustic model consists of a 66′ long tube of seamless tubing closed at each end with electromagnetic horn driver units. Short cylinders inserted in the tube represent the beds of the section, the reflection coefficient at a cylinder face being the difference of cross sectional areas of the tubing and cylinder openings over the sum of the areas. Acoustic pulses generated at one horn unit by swinging a magnet past a coil are detected both by the sender unit and by the unit at the far end of the tubing. The detected events are recorded with a high-speed drum type camera and flat amplifiers.

To test the acoustic analogue, reflection records from a seventeen bed section arranged to represent 2500′ of subsurface at a Garvin County well were compared with traces from a field seismogram shot across the well. The agreement was very satisfactory. As examples of the type of problems with which the model can deal, several common geological configurations were simulated. In one of these, one bed of a section was moved, the others remained fixed. The event on the reflection record corresponding to the moving bed confused the traces for a time equivalent to nearly te nbed thicknesses and there were a number of events, obviously not first order reflections, in the region traversed by the moving bed. Within the limitations of the model, this section represented a pinchout. An angular unconformity was simulated by moving as group the nine lowest beds of a section; the results were similar to those of the previous case.

To demonstrate the effect on a seismogram of a thick, highly reflecting near surface bed, a cylinder equivalent to a 50′ bed with a reflection coefficient of 0.8 was placed before the seventeen bed section. The record was compilcated by strong reflections between the highly reflecting bed and the other beds and the relative amplitudes of events was different from those found for the simpler section.

By varying the input pulse breath to the model, reflection records from high and low frequency pulses were obtained. As expected, the resolution of the narrowest pulse was the greatest in the sense that there was an event corresponding to nearly every bed but there were so many events of nearly equal emplitude that it was difficult to choose those representing first order reflections. The traces from the broader pulses were much simpler and nearly every event was a reflection from a group instead of a single bed. As an incidental result of this experiment, the decrease in absolute amplitude with increasing pulse breadth of reflections from beds was detected.

Two final experiments were performed with special sections. In the first of these, three cylinders each equivalent to a 100′ bed with a reflection coefficient of 0.4 were moved together. Because of the symmetry of the section, multiples were prominent. In the second experiment reflection records were obtained from a section of continuously varying acoustic impedance. Although the pulse breath was varied over a three to one range, the only reflection was from the abrupt start of the section.

The work described here was not meant to be exhaustive but merely indicative of the results which can be obtained with simple equipment of this type. Within its limitations, it is felt the acoustic model is a satisfactory analogue computer for one-dimensional seismic problems.

*Research Geophysicist, The Carter Oil Co., Tulsa. Okla.

A ONE DIMENSIONAL SEISMIC WAVE MODEL

J. F. Evans* and C. F. Hadley*

Feb. 12, 1953

Petroleum Science Hall, University of Tulsa

* Stanolind Oil and Gas Co.

TRANSMISSION CHARACTERISTICS OF NEAR SURFACE LAYERS, BARTON CO., KANSAS

Robert B. Fisher*

March 12, 1953

Petroleum Science Hall, University of Tulsa

This paper describes a method of making measurements of earth materials in place by examining pulses which were recorded at various points in the earth and comparing their harmonic analyses.

At a location southwest of the town of Great Bend, Kansas, a shot hole was drilled to a depth of 1270 feet. Geophones were cemented in surrounding holes at depths of 500 ft., 200 ft., 100 ft., 40 ft., 8 ft., and at the surface, and their leads brought out to calibrated wide frequency amplifiers. Shots were fired in the deep hole and records made on a standard recording oscillograph.

The first arrivals of the various traces were analyzed by means of the Henreci rolling sphere analyzer for their Fourier spectra.

Point by point division of two spectra was then obtained to give the transfer characteristic of the earth materials between two geophone positions.

A point of special interest was the extremely rapid attenuation of the high frequency components of the waves in the very shallow layers of the earth.

*Geophysical Research Corporation.

THE RESOLVED-TIME SEISMIC COMPUTING METHOD

R. B. Rice*

March 12, 1953

Petroleum Science Hall, University of Tulsa

A variety of reflection seismograph computing methods, which in steep-dip areas produce radically different results from the same raw data, are still being used. Some of these methods were adopted because they conform to our classical mathematical conception of the path followed by a seismic ray in traversing a sedimentary section of the earth. Other methods, which on the basis of our present knowledge appear less rational from a physical point of view, are used because of their inherent simplicity or flexibility, or because in many cases they appear to produce a better resolution of the data. The purpose of this paper is to describe a method which has been used a great deal during the past seven years throughout the Mid-Continent area. Although, except in special cases, the ray path produced by the method neither follows Snell's law nor is it a straight line, the results obtained have been very good. Furthermore, the method has the advantages of being simple and fast to use, of al-

*Phillips Petroleum Co., Bartlesville, Okla.

lowing the use of any desired velocity function and of permitting the rapid change from one velocity curve to another.

The principal assumption on which the method is based is that the ray paths as they appear on a certain type of time cross-section are straight lines and are normal to the reflection horizon on the time cross-section. This makes it possible to resolve the original data graphically in time units, which is the reason the method has been called the "resolved-time" method.

The graphical procedure for carrying out the method consists of the preparation of three different cross-sections, which are referred to as the "raw-time", "resolved-time" and "depth" sections. The raw-time and resolved-time sections can be combined into a single cross-section if one so desires. To prepare the raw-time section, reflection times, which have been corrected for weathering, angularity of path (if necessary) and to some convenient datum plane, are plotted vertically below the shotpoints or midpoints to which they correspond. The main purpose of this cross-section is to record the raw time data in such a way that it can be visually checked for errors in picking.

In preparing the resolved-time section, the shotpoints are spaced on the datum according to the horizontal times between them. Although the horizontal velocity used in computing these times can be varied at will, experience has shown that the use of the actual first-break refraction velocity between each pair of shotpoints produces the best results. After the shotpoints have been potted, a profile of the midpoints between the shot elevations and the bottom of the weathered layer is made by plotting the elevation-correction times above or below the shotpoints, according to whether they are negative or positive. The reflection times are then resolved by means of a beam compass using the points on this profile as centers and the reflection times as radii. An arc is inscribed for each reflection time at a given horizon and the reflection horizon is then represented by the line drawn tangent to each of these arcs.

Once the time profiles of the various reflection horizons have been determined, the vertical time between the reflection horizons and the datum below which the velocity function to be used applies are read below each shotpoint and recorded. The desired velocity curve is then applied to these times and the depths to the reflection horizons determined. In this manner a final depth section is constructed. The fact that no restriction of any kind is placed on the type of velocity function that must be used or on the datum below which it is applied is a decided advantage. Furthermore, with the resolved-time section as a basis, one can go back at any time additional vertical velocity information is obtained and easily and rapidly compute new depth values.

To complete the method, formulas for obtaining the direction and magnitude of maximum dip and depths to the reflection horizons from cross-spread data are included. These formulas are based on the same assumptions as those for in-line profile computations and produce results which correlate perfectly with in-line values. A special 15-inch circular slide rule was devised for use by computers to perform the cross-spread computations easily and quickly.

A new method of correcting reflection times for angularity of path is also presented which takes into consideration the effect of the angle of dip and the fact that velocity anisotropy may cause the average velocity over the

ray path to increase as the path deviates more and more from the vertical or from the normal to the reflection horizon. The amount of this velocity increase in a given area is determined empirically by finding which one of a number of different tables of corrections based on varying rates of velocity increase best smoothes out the reflection times recorded at various geophone distances. If an increase of velocity with angularity exists, usual spread-correction methods will produce too much correction for long-phone times relative to near-phone time corrections and a "saw-tooth" reflection profile will result. In general, the effect will be small unless one is dealing with spreads one-half mile long or more and with reflection times of one second or less.

Illustrative material in the paper includes a number of charts to show how displacements and depths of reflection points computed by the resolved-time method using various horizontal velocities compare with corresponding values calculated by the curve-path method. The effects of using different horizontal velocities in the computation of a fault trace and an asymmetric structural profile are also shown. In addition, raw-time, resolved-time and depth cross sections for two actual seismic profiles are presented to illustrate the use of the method and to show how effective it is in accurately mapping steeply dipping beds near or at the surface, fault planes, unconformities and narrow overturns.

SIGNAL-TO-NOISE RATIO IMPROVEMENTS BY FILTERING AND MIXING

Harold R. Frank* & William E. N. Doty*

April 9, 1953

This paper was concerned with the signal-to-noise (interference) amplitude ratio of seismograms. The problem of improving the signal-to-noise ratio by filtering and mixing is approached quantitatively. Records of known signal-to-amplitude ratio and known frequency content were made employing multiple-trace variable area equipment such that identical energy was reproduced and re-recorded through various filtering and mixing schemes and comparisons made. Equipment effects on wavelet character and stepout times are illustrated.

*Continental Oil Co., Ponca City, Okla.

BOOK REVIEW

W. T. Born*

April 9, 1953

Continental Oil Co. Research Laboratory, Ponca City

Dr. Born gave a review of the recent book by C. H. Dix entitled "Seismic Prospecting for Oil."

* Geophysical Research Corp.

THE ROLE OF GRAVITY IN AN EXPLORATION PROGRAM

May 14, 1953

Petroleum Science Hall, University of Tulsa

The meeting took the form of a symposium on the value of gravity surveys in an exploration program. Mr. Paul L. Lyons[1] acted as moderator. Dr. Sigmund Hammer[2], Mr. E. V. McCollum[3], and Mr. Joseph W. Northrup[4] acted as proponents of the gravity method, while Mr. Russel A. Weingartner[5] acted as a friendly "loyal opposition."

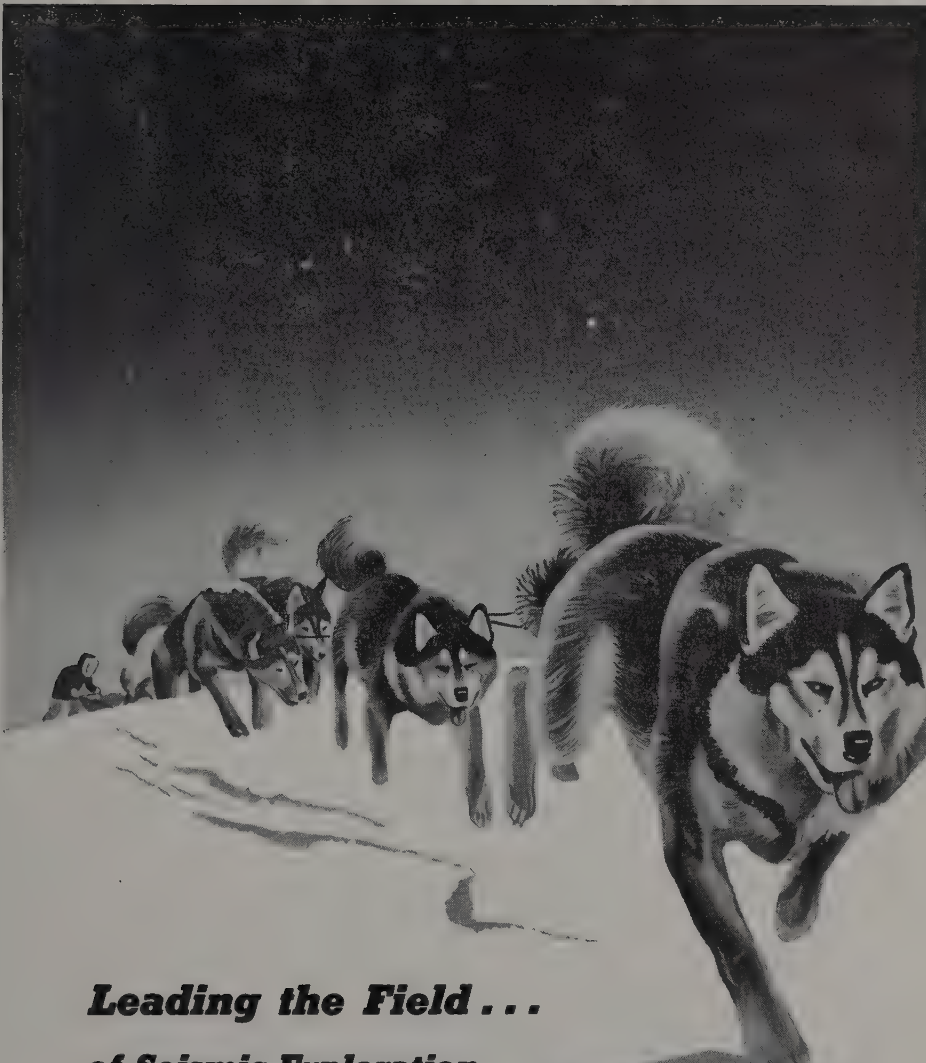
The substance of the papers, including a number of useful illustrations, have been published in the September 28, 1953 issue of the *Oil and Gas Journal*, Tulsa, Oklahoma.

[1] Anchor Petroleum Co., Tulsa.
[2] Gulf Research and Development Co., Pittsburgh.
[3] E. V. McCollum & Co., Tulsa.
[4] The California Co., New Orleans.
[5] Stanolind Oil and Gas Co., Tulsa.

THE GEOPHYSICAL SOCIETY OF TULSA

MEMBERSHIP LIST

Karl W. Abel	305 Kennedy Bldg.	Tulsa, Okla.
	Mayes-Bevan Co.	
William B. Agoes	Physics Department	
	University of Tulsa	Tulsa 4, Okla.
Warren A. Alexander	Carter Oil Co.	
	1133 No. Lewis	Tulsa, Okla.
H. H. Andrews	Seismograph Service Corp.	
	P. O. Box 1590	Tulsa 1, Okla.
Tapley G. Arnold	Geo Seis, Inc.	
	515 Thompson Bldg.	Tulsa 3, Okla.
Raymond D. Atchley	Midwestern Geophysical Laboratory	
	3401 S. Harvard	Tulsa 5, Okla.
A. C. Austin	1212 South Owasso	Tulsa 10, Okla.
John T. Baker	Carter Oil Company	
	P. O. Box 801	Tulsa 1, Okla.
Albert L. Ballou, Jr.	Manhart, Millison & Beebe	
	Jenkins Building	Tulsa 3, Okla.
Eugene F. Bangs	Aero Service Corp. (Mid-Continent)	
	P. O. Box 58	Tulsa 1, Okla.
Richard E. Barrett	3315 S. Lewis	Tulsa 15, Okla.
A. J. Barthelmes	1630 East 26th Place	Tulsa, Okla.
Joseph F. Bayhi	Carter Oil Company	
	Box 801	Tulsa 1, Okla.
W. O. Bazhaw	Hunt Oil Company	
	700 Mercantile Bank Bldg.	Dallas, Texas
Ronald E. Beck	414 Bank Building	Bartlesville, Okla.
A. A. Becker	Continental Oil Company	Ponca City, Okla.
P. I. Bediz	Century Geophysical Corporation	
	1333 North Utica	Tulsa 10, Okla.
John Bensko, Jr.	Mid-Continent Petroleum Corp.	
	P. O. Box 381	Tulsa 2, Okla.
Thomas J. Bevan	Consultant	
	914 American Airlines Bldg.	Tulsa, Okla.
F. L. Bishop	1408 Philtower Bldg.	Tulsa 3, Okla.
J. R. Blaisdell	Seismograph Service Corp.	
	P. O. Box 1590	Tulsa 1, Okla.
Carl W. Blakey	Manhart, Millison & Beebe	
	503 Jenkins Building	Tulsa 3, OKLA.
J. E. Bondurant	400 W. Frank Phillips Blvd.	Bartlesville, Okla.
Ibrey T. Bonnette	1515 South Carson	Tulsa 14, Okla.
Frank W. Borman	Amerada Pet Corp.	
	Box 2040	Tulsa, Okla.
W. T. Born	2607 No. Boston Place	Tulsa 6, Okla.
F. G. Boucher	Carter Oil Co.	
	Box 801	Tulsa, Okla.
Charles P. Bowditch	4651 S. St. Louis	Tulsa 5, Okla.



D. C. Bowman	5546 E. 4th Terrace	Tulsa 12, Okla.
Robert B. Bradley	2745 So. Gary Dr.	Tulsa, Okla.
R. M. Bradley	Cities Service Oil Co.	Bartlesville, Okla.
H. R. Breck	Seismograph Service Corp. P. O. Box 1590	Tulsa 1, Okla.
W. B. Brinnon	Skelly Bldg.	Tulsa 3, Okla.
Charles C. Brooks	521 McBirney Bldg.	Tulsa 3, Okla.
W. M. Brooks	1916 So. Delaware	Tulsa 4, Okla.
Frank E. Brown	Box 2208	Tulsa, Okla.
H. W. Brown	Carter Oil Co. Box 801	Tulsa, Okla.
A. B. Bryan	The Carter Oil Co Box 801	Tulsa, Okla.
Carl L. Bryan	Consultant 804 Texas Eastern Bldg.	Shreveport, La.
Charles A. Bucklin	422 So. 71st East Ave.	Tulsa 15, Okla.
C. E. Buffum	Stanolind O. & G. Co. Box 591	Tulsa, Okla.
Kay N. Burns	1770 W. Fairview St.	Tulsa, Okla.
Charles L. Bury	Box 1590	Tulsa 1, Okla.
Francis H. Cady	250 E. 34th St.	Tulsa 5, Okla.
Ray L. Calkins	1801 N. Columbia Place	Tulsa 10, Okla.
Colin C. Campbell	Society of Exploration Geophysicists 624 South Cheyenne	Tulsa 3, Okla.
Francis F. Campbell	Amerada Pet. Corp. Box 2040	Tulsa, Okla.
W. A. Carruth	Box 2040	Tulsa, Okla.
R. F. Christy	Shell Oil Co. Box 1191	Tulsa, Okla.
Everette H. Clark	Skelly Oil Company P. O. Box 1650	Tulsa 2, Okla.
R. C. Clark	P. O. Box 801	Tulsa 2, Okla.
Neal Clayton	Century Geophysical Corporation Box 6216	Tulsa 10, Okla.
J. A. Coffeen	Sinclair Oil & Gas Company P. O. Box 99	Jackson, Miss.
R. Clare Coffin	Stanolind O. & G. Co. Box 591	Tulsa, Okla.
J. E. Connell	Box 2040	Tulsa, Okla.
E. Allen Cook	807-B Osage Drive	Tulsa, Okla.
E. H. Cooley	Stanolind O. & G. Co. Yale at 41st Street	Tulsa, Okla.
Harry M. Cooper Jr.	Deep Rock Oil Corp. P. O. Box 1051	Tulsa 2, Okla.
Jack R. Cooper	Stanolind O. & G. Co. Box 591 (Research Center)	Tulsa, Okla.
Jack M. Copass	Copass & Sullivan, Consulting Geologists 409 Oil Capital Building	Tulsa 3, Okla
Ralph L. Cordell	1103 N. New Haven	Tulsa 12, Okla.

F. R. Coryn	P. O. Box 2420	Tulsa 1, Okla.
William H. Courtier	Phillips Pet. Co.	
	Room 414 Bank Bldg.	Bartlesville, Okla.
John M. Crawford	Development & Research Dept.	
	Continental Oil Company	Ponca City, Okla.
Carl C. Crenshaw	Phillips Pet Co.	Bartlesville, Okla.
Stewart Cronin	Box 271	Tulsa 2, Okla.
Edward J. Crossland	Seismograph Service Corporation	
	P. O. Box 1590	Tulsa 1, Okla.
Kenneth C. Crumrine	The Carter Oil Company	
	P. O. Box 801	Tulsa 1, Okla.
Dallas R. Davis	Industrial Electronic Supply Co.	
	1124 East Fourth St.	Tulsa 10, Okla.
Richard M. Davis	Carter Oil Company	
	1116 Liberty Bank Bldg.	Oklahoma City, Okla.
Charles E. Day	Geophysicail Research Corp.	
	2607 North Boston Place	Tulsa 6, Okla.
M. A. Day	c/o Consolidated Geo. Surveys	
	211 Boulder Bldg.	Tulsa, Okla.
Raymond G. De Verse	4158 E. 38th St.	Tulsa 15, Okla.
Opie Dimmick	Century Geophysical Corp.	
	1333 No. Utica	Tulsa, Okla.
William E. N. Doty	Continental Oil Co.	
	Drawer 1267	Ponca City, Okla.
C. P. Durant	Interstate Exploration Company	
	2818 South Harvard	Tulsa 1, Okla.
Karl Dyk	Stanolind O. & G. Co.	
	Box 591	Tulsa, Okla.
George S. Dzwons	512 Orpheum Bldg.	Tulsa 3, Okla.
David H. Earle	1205 S. Owasso Ave.	Tulsa 10, Okla.
Carl L. Edmonson	Carter Oil Co., Box 801	Tulsa, Okla.
Daniel G. Egan	1301½ S. Yale	Tulsa 4, Okla.
Joseph D. Eisler	Stanolind O. & G. Co.	
	41st & Yale	Tulsa, Okla.
S. D. Elliott	Phillips Pet. Co.	
	400 W. Frank Phillips Blvd.	Bartlesville, Okla.
William M. Erdahl	Skelly Oil Co, Box 1650	Tulsa, Okla.
John O. Erickson	Phillips Pet. Co., Box 1074	Artesia, N. Mex.
John B. Etnyre	Geology Dept., Sinclair Oil & Gas Co.	
	Box 521	Tulsa 1, Okla.
Julian F. Evans	Stanolind O. & G. Co., Bov 591	Tulsa, Okla.
	Box 801	Tulsa, Okla.
Floyd F. Farley	1642 South Oak	Bartlesville, Okla.
L. Y. Faust	Amerada Pet Corp.	
	Box 2040	Tulsa, Okla.
George F. Ferguson	4672 S. St. Louis	Tulsa 5, Okla.
Henry B. Ferguson	2632 East 3rd St.	Tulsa 4, Okla.
John L. Ferguson	Deep Rock Oil Corp.	
	Box 1051	Tulsa, Okla.
Paul M. Ferguson	1703 North College	Tulsa 6, Okla.

emblem

of experience

2200* man-years of it-

Wherever there is exploration activity, you will see this emblem. In announcing its Awards Program, GSI pays tribute to the achievement of its people. Their collective ability is GSI's greatest single asset . . . out of which has developed the stability and experience that characterize GSI.

	Awards This Year	Years of Experience
*	11	More than 20
	34	More Than 15
	26	More Than 10
	123	More Than 5
	Total 194	More Than 2200

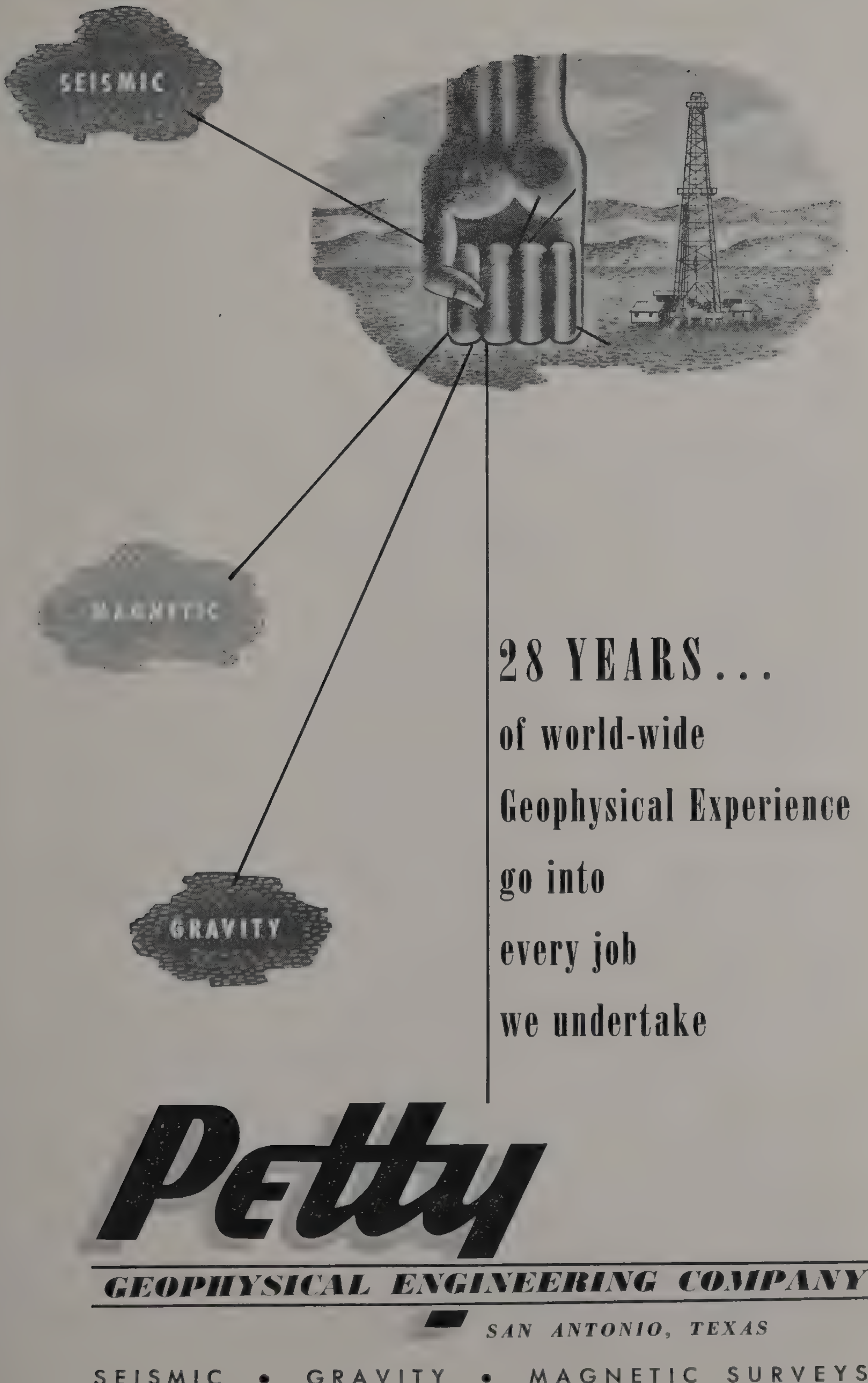
GEOPHYSICAL SERVICE INC.

6000 LEMMON AVENUE • DALLAS, TEXAS

Craig Ferris	1243 E. 28th St.	Tulsa 5, Okla.
R. K. Finley	1218 South Vandalia	Tulsa 12, Okla.
Robert S. Finn	Lorac Service Corp. Box 1590	Tulsa, Okla.
J. L. Fisher	Century Geophysical Corp. 1333 No. Utica	Tulsa, Okla.
Allen Foster	Consultant 324 Terrace Drive	Pauls Valley, Okla.
Kennith Frakes	Midwestern Geophysical Laboratory 3401 S. Harvard	Tulsa 15, Okla.
Harold R. Frank	Continental Oil Company Geophysical Section	Ponca City, Okla.
John V. Franklin	The Atlantic Refining Co. 830 Kennedy Bldg.	Tulsa 3, Okla.
Orville H. Frazier	Amerada Pet Corp. Box 2040	Tulsa, Okla.
R. L. Frossard	Sinclair Oil & Gas Co. Box 521	Tulsa, Okla.
C. H. Frost	Frost Geophysical Corporation P. O. Box 58	Tulsa 1, Okla.
Paul W. Fullerton	2617 E. 18th St.	Tulsa 4, Okla.
James R. Gaebe	435 Drake Drive	Ponca City, Okla.
J. P. Garner, President	Tulsa Exploration Co. 501 Oil Capitol Bldg.	Tulsa, Okla.
Roy E. Garten, Jr.	Continental Oil Co. Drawer 1267	Ponca City, Okla.
Don Gilkison	Gulf Oil Corporation P. O. Box 1971	Casper, Wyoming
Andrew Gilmour	Amerada Pet Corp. Box 2040	Tulsa, Okla.
Robert H. Gish	3523 S. Knoxville	Tulsa 15, Okla.
Stanley E. Giulio	Carter Oil Co. Box 801	Tulsa, Okla.
David S. Godshalk	Continental Oil Company Drawer 1267	Ponca City, Okla.
Louis P. Goetz	1340 S. Urbana	Tulsa, Okla.
M. S. Graham	Stanolind Oil & Gas Co. Box 591	Tulsa, Okla.
G. C. Green	Oil Capitol Electronics Corp. 923 E. 4th	Tulsa 10, Okla.
R. P. Green	Box 2203	Tulsa, Okla.
Thom H. Green	Fargo Oils, Ltd. 133 6th Avenue, East	Calgary, Alberta, Canada
T. S. Green	Sunray Oil Co. P. O. Box 2039	Tulsa, Okla.
Charles F. Hadley	Stanolind O. & G. Co. Box 591	Tulsa, Okla.
Clifford E. Hallock, Jr.	411 First National Bank Bldg.	Bartlesville, Okla.
J. W. Hammond	718 S. Sandusky	Tulsa 12, Okla.

E. J. Handley	Midwestern Geophysical Lab.	
	3401 So. Harvard	Tulsa, Okla.
Bruce H. Harlton	Amerada Pet. Corp.	
	Box 2040	Tulsa, Okla.
James C. Harper	3446 S. Zunis	Tulsa 5, Okla.
Wayne E. Harrison	307 S. New Haven	Tulsa 12, Okla.
Ralph E. Hartline	1943 S. College	Tulsa 4, Okla.
Castle J. Harvey	Deep Rock Oil Corp.	
	Box 1051	Tulsa, Okla.
Oscar Hatcher	Kidd Williams Drilling Co.	
	943 Kennedy Bldg.	Tulsa 3, Okla.
James E. Hawkins	Seismograph Service Corp.	
	Box 1590	Tulsa, Okla.
F. M. Hawpe	4635 E. 13th Place	Tulsa 12, Okla.
C. E. Hendricks	5500 E. 51st St., R. R. #7	Tulsa, Okla.
Ernest W. Heyl	Route #1, Box 359AS	Bartlesville, Okla.
Haines C. Hibbard	The Carter Oil Co.	
	1133 No. Lewis	Tulsa, Okla.
John H. Hidy	P. O. Box 58	Tulsa, Okla.
A. J. Hintze	Phillips Pet. Corp.	Bartlesville, Okla.
Henry Hobart, Jr.	4945 S. Cincinnati	Tulsa 5, Okla.
R. B. Hollingsworth	Stanolind O. & G. Co.	
	Box 591	Tulsa, Okla.
John M. Horeth	2431 So. Pittsburg	Tulsa 5, Okla.
A. Maxwell House	Seismograph Service Corp.	
	Box 1590	Tulsa, Okla.
Roland F. Hughes	915 North 3rd St.	Ponca City, Okla
C. R. Humphrey	Seisdrill, Inc.	
	515 Thompson Bldg.	Tulsa 3, Okla.
James R. Hunt	Amerada Pet Corp.	
	Box 2040	Tulsa, Okla.
Clare Hurry	The Carter Oil Co.	
	Box 801	Tulsa, Okla.
John S. Hutchison	Carter Oil Company	
	P. O. Box 801	Tulsa 1, Okla.
A. E. Ibach	Aero Service Corp. (Mid-Continent)	
	P. O. Box 58	Tulsa 1, Okla.
Philip C. Ingalls	Oil & Gas Journal	
	Box 1260	Tulsa 1, Okla.
Arland I. Innes	Amerada Pet. Corp.	
	Box 2040	Tulsa, Okla.
Judson G. Jackson	Seismograph Service Corp.	
	Box 1590	Tulsa, Okla.
Chet H. Jameson, Jr.	Manhart, Millison & Beebe	
	503 Jenkins Bldg.	Tulsa, Okla.
Stephen J. Jatras	Midwestern Geophysical Laboratory	
	3401 S. Harvard	Tulsa 15, Okla.

James F. Johnson	Sinclair Research Labs Inc 860 North Lewis	Tulsa 4, Okla.
J. Rudolph Johnson	Geophysical Dept. Phillips Petroleum Co.	Bartlesville, Okla.
R. N. Jolly	3908 East 31st St.	Tulsa 15, Okla.
H. Joe Jones	Sinclair Research Labs, Inc. Whittier Station Box 3006	Tulsa 8, Okla.
V. L. Jones	1412 S. Norfolk	Tulsa, Okla.
Cecil Jordan	Continental Oil Co. Drawer 1267	Ponca City, Okla.
Douglas J. Kartman	P. O. Box 1590	Tulsa 1, Okla.
Oscar J. Kastner, Jr.	1635 S. Knoxville	Tulsa 10, Okla.
R. C. Kendall	Shell Oil Company, Inc. Box 1191	Tulsa, Okla.
W. B. Kendall	2607 No. Boston Place	Tulsa 6, Okla.
John J. Kenton	Stanolind Oil & Gas Co. Box 591	Tulsa 2, Okla.
J. L. Kezeler	1130 S. New Haven	Tulsa 12, Okla.
Laurence K. King	1000 South Pine	Ponca City, Okla.
Frank R. Kittredge	Sinclair Oil & Gas Co. Box 521	Tulsa 2, Okla.
F. G. Knight	Ohio Oil Company Box 1129	Shreveport, La.
B. W. Koeppel	Seismograph Service Corp. Box 1590	Tulsa 1, Okla.
William C. Lamb	P. O. Box 661	Tulsa 1, Okla.
W. W. Lamkin	Stanolind O. & G. Co. Box 591	Tulsa, Okla.
Harold M. Lang	Stanolind O. & G. Co. Box 591	Tulsa, Okla.
Charles C. Lash	Stanolind O. & G. Co. Box 591	Tulsa, Okla.
J. Austin Lawless	Stanolind O. & G. Co. Box 591	Tulsa, Okla.
Franklin L. Lawrence	2720 E. 2nd St.	Tulsa, Okla.
K. M. Lawrence	Amerada Pet Corp. Box 2040	Tulsa, Okla.
Norman J. Lea	P. O. Box 2420	Tulsa 2, Okla.
Ruth Rice Leas	Box 591	Tulsa 2, Okla.
George W. Lisle	Exploration Surveys, Inc. 248 East 29th Street	Tulsa 5, Okla.
Edgar R. Locke	Manhart, Millison & Beebe Jenkins Bldg.	Tulsa, Okla.
C. C. Ludwick	Shell Oil Company Box 1090	Rapid City, South Dakota
Ralph D. Lynn	The Carter Oil Co. Box 801	Tulsa, Okla.


SEISMIC
MAGNETIC
GRAVITY
28 YEARS...
of world-wide
Geophysical Experience
go into
every job
we undertake
Petty
GEOPHYSICAL ENGINEERING COMPANY
SAN ANTONIO, TEXAS
SEISMIC • GRAVITY • MAGNETIC SURVEYS

Paul L. Lyons	Anchor Petroleum Atlas Life Bldg.	Tulsa 3, Okla.
C. H. McAlister	Consultant 2525 East 20th	Tulsa 4, Okla.
Ed R. McCarter	65 E. 53rd Street	Tulsa 15, Okla.
John C. McCaslin	Oil & Gas Journal Box 1260	Tulsa, Okla.
E. V. McCollum	515 Thompson Bldg.	Tulsa, Okla.
Benjamin F. McCoy	146 N. Delaware Place	Tulsa 4, Okla.
Guy I. McCracken	P. O. Box 661	Tulsa 2, Okla.
L. B. McManis	3106 E. 26th Place	Tulsa 5, Okla.
Perry M. McNally	Phillips Petroleum Co. 417 Bank Building	Bartlesville, Okla.
E. M. McNatt	The Carter Oil Co. Box 801	Tulsa 1, Okla.
T. A. Manhart	Manhart, Millison & Beebe 503 Jenkins Bldg.	Tulsa, Okla.
Samuel T. Martner	Stanolind Oil & Gas Co. P. O. Box 591	Tulsa 1, Okla.
R. L. Mathieson	1015 So. College	Tulsa, Okla.
J. R. Maxey	3804 S. St. Louis	Tulsa 5, Okla.
Tom D. Mayes	Mayes-Bevan Co., Kennedy Bldg.	Tulsa, Okla.
H. L. Mendenhall	1804 S. Dewey	Bartlesville, Okla.
T. H. Michell	Du Pont, 120 E. 31st St.	Tulsa, Okla.
James W. Miller	Stanolind O. & G. Co, Box 591	Tulsa, Okla.
Robert D. Miller	c/o Shell Oil Co., Inc. 850 1st National Bldg.	Oklahoma City, Okla.
Vincent Miller	Box 1289	Bartlesville, Okla.
Robert G. Mills	Precision Exploration Company 810 American Airlines Bldg.	Tulsa 3, Okla.
Fielding L. Mitchell	The Carter Co., Box 801,	Tulsa, Okla.
H. T. Monhollon	2308 S. Florence Place	Tulsa 5, Okla.
Harriett H. Monroe	544 S. Zunis	Tulsa 4, Okla.
Herbert H. Moody	Geophysical Department Continental Oil Company	Ponca City, Okla.
Homer C. Moore	Oil Exploration, Inc. 501 Oil Capitol Bldg	Tulsa, Okla.
W. F. Moore, Jr.	Phillips Petroleum Co. 400 West Frank Phillips Blvd.	Bartlesville, Okla.
W. Lee Moore	Petty Geophysical Eng. Co. 1205 Hunt Bldg.	Tulsa, Okla.
Madeline Moote	Box 591	Tulsa, Okla.
Floyd H. Morris	414 1st Nat'l. Bank Bldg.	Bartlesville, Okla.
G. Robert Morrow	Midwestern Geoph. Lab. 3401 S. Harvard	Tulsa 15, Okla.
M. E. Morrow	Midwestern Geoph. Lab 3401 S. Harvard	Tulsa 15, Okla.
R. W. Mossman	Seismograph Service Corp. Box 1590	Tulsa, Okla.

Stephen D. Moxley, Jr.	336 S. Sunset	Ponca City, Okla.
Kenneth Murphey	c/o Consolidated Geo. Surveys 211 Boulder Building	Tulsa, Oklahoma
James R. New	c/o Consolidated Geo. Surveys 211 Boulder Bldg.	Tulsa, Okla.
George R. Newton	2602 E. 14th Pl.	Tulsa 4, Okla.
Max Nichols	c/o Consolidated Geo. Surveys 211 Boulder Building	Tulsa, Okla.
John Norris	3811 East 22nd St.	Tulsa 5, Okla.
Walter O. Novelly	Republic Exploration Co. Box 2208	Tulsa 1, Okla.
Donald G. O'Brien	3401 S. Harvard	Tulsa 15, Okla.
Charles W. Oliphant	Oliphant Labs. Inc., 1905 National Bank of Tulsa Bldg.	Tulsa 3, Okla.
H. E. Owen	The Carter Oil Co., Box 801	Tulsa, Okla.
John E. Owen	2607 N. Boston Place	Tulsa 6, Okla.
John E. Palmer	3239 E. 4th Street	Tulsa 4, Okla.
Harry L. Pelzer	Box 3157 Whittier Station	Tulsa, Okla.
V. A. Peterson	P. O. Box 521	Tulsa, Okla.
Joe A. Phillips	International Drilling Company 910 S. Boston Avenue	Tulsa 3, Okla.
Raymond G. Piety	504 Cherokee Ave.	Bartlesville, Okla.
Robert R. Pittman	3503 S. Yorktown	Tulsa, Okla.
Richard A. Pohly	Box 1590	Tulsa, Okla.
Newell Pottorf	1707 East 14th St.	Tulsa 4, Okla.
Melvin E. Putnam	Seismograph Service Corp. Box 1590	Tulsa, Okla.
David E. Reed	1528 E. 37th St.	Tulsa, Okla.
A. C. Reid	1718 S. Delaware Pl.	Tulsa, Okla.
Roger W. Reynolds	5145 S. Trenton	Tulsa 5, Okla.
R. B. Rice	Phillips Pet. Co.	Bartlesville, Okla.
Norman Ricker	The Carter Oil Co. Box 801	Tulsa, Okla.
James J. Roark	1218 S. Darlington	Tulsa 4, Okla.
Price E. Roberts	Oil Exploration, Inc. 501 Oil Capital Bldg.	Tulsa 3, Okla.
Van Roberts	Box 1590	Tulsa, Okla.
K. A. Robertson	Precision Exploration Company 810 American Airlines Bldg.	Tulsa 3, Okla.
W. Bernard Robinson	Gulf Research & Development Co. P. O. Box 661	Tulsa 2, Okla.
W. J. Robinson	4623 S. St. Louis	Tulsa 5, Okla.
Edward O. Roe	3805 E. Independence	Tulsa 4, Okla.
Cletus D. Roemer	Consolidated Geophysical Surveys 211 Boulder Bldg.	Tulsa, Okla.
J. C. Rollins	Aero Service Corp. (Mid-Continent) P. O. Box 58	Tulsa 1, Okla.
Charles M. Ross	1742 South Evanston	Tulsa 4, Okla.

Ben F. Rummerfield	Century Geophysical Corp.	
	Box 6216	Tulsa 10, Okla.
John J. Rupnik	1507 E. 34th St.	Tulsa 5, Okla.
Robert W. Saubert	Box 1590	Tulsa 1, Okla.
S. Wm. Schoellhorn	Seismograph Service Corporation	
	P. O. Box 1590	Tulsa 1, Okla.
William W. Schriever	1742A East 22nd Pl.	Tulsa 5, Okla.
C. B. Scott	2527 S. Evanston	Tulsa 5, Okla.
Frank Searcy	Drawer 1267	Ponca City, Okla.
Charles W. Shannon	Sinclair Research Lab., Inc.	
	360 North Lewis	Tulsa 4, Okla.
E. Joe Shimek	Geophysical Associates	
	Box 6005	Houston 6, Texas
W. B. Sibley	1314 S. Braden	Tulsa 4, Okla.
Danial Silverman	Stanolind O. & G. Co.	
	Box 591	Tulsa, Okla.
Ray L. Six	Geological Dept.	
	Oklahoma A & M College	Stillwater, Okla.
J. D. Skelton	2624 E. 4th St.	Tulsa 4, Okla.
J. E. Skinner	Stanolind Oil & Gas Co., Research Center	
	41st Street & Yale	Tulsa, Okla.
Gerald N. Smith	2141 East 25th	Tulsa 5, Okla.
Richard E. Smythe	Sub Surface Seismograph Corp.	
	Box 5142	Tulsa, Okla.
Leland Snow	Petty Geophysical Engineering Co.	
	1205 Hunt Building	Tulsa, Okla.
Allan D. Sontag	The Carter Oil Company	
	P. O. Box 801	Tulsa 1, Okla.
William A. Sorge	The Carter Oil Co.	
	P. O. Box 801	Tulsa 2, Okla.
Tom. F. Southgate	Amerada Pet. Corp.	
	Box 2040	Tulsa, Okla.
A. Leon Spangler	Seismograph Service Corporation	
	P. O. Box 1590	Tulsa 1, Okla.
Neil R. Sparks	Stanolind O. & G. Co.	
	Box 591	Tulsa, Okla.
John A. Stafford	1601 N. Detroit	Tulsa 6, Okla.
T. V. Stephens	2728 East 44th Place	Tulsa 15, Okla.
Thomas C. Stotler	Stanolind O. & G. Co.	
	Box 591	Tulsa, Okla.
Edward B. Stover, Jr.	Box 591	Tulsa, Okla.
Clyde E. Stufflebeam	Century Geophysical Co.	
	1333 N. Utica St.	Tulsa 10, Okla.
R. F. Sutherlin	1217 S. Zunis St.	Tulsa 4, Okla.
Bird G. Swan	Drawer 1267	Ponca City, Okla.
Gilbert Swift	Well Surveys, Inc.	
	624 E. 4th St.	Tulsa 3, Okla.
Albert W. Taylor	Box 2040	Tulsa, Okla.
Garvin L. Taylor	Stanolind O. & G. Co.	
	Box 591	Tulsa, Okla.

Joseph W. Tedder, Jr.	1529 S. Jamestown	Tulsa, Okla.
Delbert E. Thomas	1527 South Gary	Tulsa 4, Okla.
T. J. Thomas	Sunray Oil Corporation First National Bldg.	Tulsa 3, Okla.
R. R. Thompson	Carter Oil Co.	Tulsa 2, Okla.
H. M. Thralls	Seismograph Service Corp. Box 1590	Tulsa 1, Okla.
Bob L. Tucker	3301 W. Easton St.	Tulsa 6, Okla.
R. H. Tucker	Cities Service Oil Co.	Bartlesville, Okla.
Gordon Tyler	Gordon Tyler Company 703 Oil Capitol Bldg.	Tulsa 3, Okla.
Jerry E. Upp	P. O. Box 521	Tulsa, Okla.
R. F. Van Cleave	P. O. Box 5243	Tulsa 1, Okla.
W. H. Van Horn	Seismograph Service Corp. P. O. Box 1590	Tulsa 1, Okla.
Stefan Von Croy	Sunray Oil Corporation First National Bldg.	Tulsa 3, Okla.
Bryan Vorheis	Continental Oil Co. Drawer 1267	Ponca City, Okla.
W. Day Waldrep	Sunray Oil Corporation Box 2039	Tulsa, Okla.
Edward R. Walker	1446 S. Erie	Tulsa 12, Okla.
George G. Walton	Box 801	Tulsa, Okla.
John E. Ward	Sinclair Oil & Gas Co Room 420 Continental Bldg.,	Denver, Colo.
D. F. Warner	Seismograph Service Corp. Box 1590	Tulsa 1, Okla.
Donald Warnken	2743 E. 6th St.	Tulsa 4, Okla.
H. B. Warren	International Drilling Company 910 S. Boston Ave.	Tulsa 3, Okla.
Robert J. Watson	Carter Oil Company Box 801	Tulsa 2, Okla.
B. B. Weatherby	Box 2040	Tulsa 2, Okla.
David R. Weichert	Century Geophysical Corp. 1333 N. Utica	Tulsa, Okla.
Rudolph F. Weichert	c/o Carter Oil Co. P. O. Box 801	Tulsa 2, Okla.
R. A. Weingartner	Stanolind Oil & Gas Co. P. O. Box 591	Tulsa 1, Okla.
Frederick H. Wessman	The Carter Oil Company P. O. Box 801	Tulsa 2, Okla.
G. H. Westby	Seismograph Service Corp. P. O. Box 1590	Tulsa 1, Okla.
James A. Westphal	Seismograph Service Corporation P. O. Box 1590	Tulsa 1, Okla.
Loren E. Whitehead	Drawer 1267	Ponca City, Okla.
M. B. Widess	Stanolind O. & G. Co. Box 591	Tulsa, Okla.

Stanley W. Wilcox	Box 1590	Tulsa, Okla.
Bruce F. Wiley	912 Shawnee Ave.	Bartlesville, Okla.
P. S. Williams	The Carter Oil Co.	
	Box 801	Tulsa, Okla.
Richard Williams	c/o Seismic Inc.	
	P. O. Box 5163	Tulsa, Okla.
Thomas H. Williams III	Republic Exploration Co.	
	Box 2208	Tulsa, Okla.
James N. Wilson	Box 1590	Tulsa 1, Okla.
John H. Wilson	Consultant	
	1201 Sinclair Bldg.	Ft. Worth, Texas
J. R. Winnek	Dayton Exploration Company	
	600 East Fourth St.	Tulsa 3, Okla.
Herman Wirz, Jr.	Box 801	Tulsa, Okla.
Earl M. Wolters	Phillips Pet. Co.	Bartlesville, Okla.
J. T. Woodburn	Petroleum Consultants, Inc.	
	515 South Main St.	Tulsa 3, Okla.
J. P. Woods	Atlantic Refining Company	
	Box 2819	Dallas, Texas
Ray Zongker	212 South Wheeling St.	Tulsa 4, Okla.
William J. Zwart	Box 2040	Tulsa, Okla.

MEMBERSHIP LIST BY COMPANY AFFILIATION AS OF JUNE 25, 1953

AERO SERVICE CORPORATION ..... 236 E. Courtland, Philadelphia, Pa. Michigan 4-8500

William B. Agocs
Eugene F. Bangs
A. E. Ibach
J. C. Rollins

AMERADA PETROLEUM CORPORATION ..... Beacon Bldg. 3-6251

Research Laboratory ..... 2607 N. Boston 3-1119

Frank W. Borman
Francis F. Campbell
W. A. Carruth
J. E. Connell
L. Y. Faust
Orville H. Frazier
Andrew Gilmour
Bruce H. Harlton
James R. Hunt
Arland I. Innes
K. M. Lawrence
Charles M. Ross
Tom F. Southgate
Albert W. Taylor
B. B. Weatherby
William J. Zwart

ANCHOR PETROLEUM COMPANY ..... Atlas Bldg. 2-7261

Robert B. Bradley
Paul L. Lyons

ATLANTIC REFINING COMPANY ..... Kennedy Bldg. 4-8155

District Office ..... Oil Capital Bldg. 2-5682

John V. Franklin
J. P. Woods

THE CARTER OIL COMPANY ..... Nat'l Bank of Tulsa Bldg. 2-6101

Research Laboratory and Shop ..... 1133 N. Lewis 6-1154

Warren A. Alexander
John T. Baker
Joseph F. Bayhi
Ibrey T. Bonnette
F. G. Boucher
H. W. Brown
A. B. Bryan
Kay N. Burns
Francis H. Cady
Ray L. Calkins
R. C. Clark
E. Allen Cook
Kenneth C. Crumrine
Richard M. Davis
Carl L. Edmonson
Daniel G. Egan
Henry B. Ferguson
Stanley E. Giulio
Hainas C. Hibbard
John M. Horeth
Clare Hurry
John S. Hutchison
R. N. Jolly
Franklin L. Lawrence
Ralph D. Lynn
Ed R. McCarter
Benjamin F. McCoy
E. M. McNatt
Fielding L. Mitchell
H. E. Owen
Norman Ricker
James J. Roark
Edward O. Roe
William W. Schriever
C. B. Scott
J. D. Skelton
Allan D. Sontag
William A. Sorge
R. R. Thompson
George G. Walton
Robert J. Watson
Rudolph F. Weichert
Frederick H. Wessman
P. S. Williams
Herman Wirz, Jr.

C. E. HENDRICKS COMPANY ..... 5500 E. 51st 7-0234

C. E. Hendricks

CENTURY GEOPHYSICAL CORPORATION ..... 1333 N. Utica 5-7111

Richard E. Barrett
P. I. Bediz
Charles A. Bucklin
Neal Clayton
Opie Dimmick
David H. Earle
J. L. Fisher
Julius H. Johnson
Robert R. Pittman
Roger W. Reynolds
Ben F. Rummerfield
John A. Stafford
Clyde E. Stufflebeam
Bob L. Tucker
David R. Weichert

CITIES SERVICE OIL COMPANY ..... Masonic-Empire Bldg., Bartlesville 909

R. M. Bradley
R. H. Tucker

CONSOLIDATED GEOPHYSICAL SURVEYS . 19 W. 10th, Tulsa 2-1811

M. A. Day
Cletus D. Roemer
Oscar J. Kastner, Jr.
Kenneth Murphey
James R. New
Max Nichols

CONSULTANT

Thomas J. Bevan
F. L. Bishop
Carl J. Bryan
Allen Foster
Henry Hobart, Jr.
V. L. Jones
C. H. McAlister
Gerald N. Smith
John H. Wilson

CONTINENTAL OIL COMPANY ..... 1000 S. Pine St., P. O. Drawer 1267, Ponca City RO 5-6661

A. A. Becker
Frank Clynch
John M. Crawford
William E. N. Doty
Harold R. Frank
James R. Gaebe
Roy E. Garten, Jr.
David S. Godshalk
Roland F. Hughes
Cecil Jordan
Laurence K. King
Herbert H. Moody
Stephen D. Moxley
Frank Searcy
Bird G. Swan
Byron Vorheis
E. L. Wells
Loran E. Whitehead

COPASS & SULLIVAN ..... Oil Capitol Bldg., Tulsa 3-0874

Jack M. Copass

DAYTON ENGINEERING COMPANY ..... 600 E. 4th, Tulsa 2-7223

W. B. Sibley
R. F. Sutherlin

DAYTON EXPLORATION COMPANY ....600 E. 4th, Tulsa 3-6845
J. R. Winnek

DEEP ROCK OIL CORPORATION..........................Atlas Bldg., Tulsa 2-4351
Harry M. Cooper, Jr. John L. Ferguson Castle J. Harvey

E. I. DUPONT DE NEMOURS & COMPANY....120 E. 31st St., Tulsa 72-1187
T. H. Mitchell

ELECTRICAL ENGINEER
George S. Dzwons

E. V. McCOLLUM COMPANY.............Thompson Bldg., Tulsa 2-3149
E. V. McCollum Craig Ferris

EXPLORATION CONSULTANTS INC. ....Jenkins Bldg., Tulsa 2-0929
J. R. Maxey

EXPLORATION SERVICE COMPANY ....Box 1289, Bartlesville 2225
Vincent Miller

EXPLORATION SURVEYS INC. ....248 E. 29th St., Tulsa 7-9535
George W. Lisle

FROST GEOPHYSICAL CORP.................4408 S. Peoria, Tulsa 7-3313
C. H. Frost John H. Hidy

FARGO OILS, LTD. ....133 6th Ave., East, Calgary, Alberta Canada
Thom H. Green

GEOPHYSICAL ASSOCIATES..................Box 6005 Houston 6, Texas MOhawk 4531
E. Joe Shimek

GEOPHYSICAL CONSULTANTS.......521 McBirney Bldg., Tulsa 3-9454
C. C. Brooks

GEOPHYSICAL RESEARCH CORPORATION..........2607 N. Boston Pl., Tulsa 3-1119
W. T. Born James C. Harper John E. Owen
Charles E. Day W. B. Kendall

GEORGE FERGUSON DRILLING COMPANY .. 1338 E. 34th, Tulsa 72-1643
George F. Ferguson

GEOSEIS, INC. ....515 Thompson Bldg., Tulsa 2-3149 & 2-3140
Tapley G. Arnold

GORDON TYLER COMPANY ....Oil Capitol Bldg., Tulsa 4-7191
Gordon Tyler

GULF OIL CORPORATION.................................Gulf Bldg., Tulsa 4-2121
Don Gilkison William C. Lamb

GULF RESEARCH & DEVELOPMENT COMPANY .....Gulf Bldg., Tulsa 4-2121
Guy I. McCracken W. Bernard Robinson

HUNT OIL COMPANY (DALLAS).......700 Mercantile Bldg., Dallas, Tex., RIverside 3561
W. O. Bazhaw

INDUSTRIAL ELECTRONIC SUPPLY CO..........1124 E. 4th, Tulsa 3-8122
W. M. Brooks Dallas R. Davis

INTERNATIONAL BUSINESS MACHINES .....907 S. Main, Tulsa 4-2464
Paul W. Fullerton

INTERNATIONAL DRILLING COMPANY.....910 S. Boston, Tulsa 5-7754
Joe A. Phillips H. B. Warren

INTERSTATE EXPLORATION COMPANY 2818 S. Harvard, Tulsa 72-8401
C. P. Durant F. M. Hawpe R. F. Van Cleave

KEY EXPLORATION COMPANY.................P. O. Box 1824, Tulsa 6-8468
J. L. Kezeler

KEWANNE OIL COMPANY ....Kennedy Bldg., Tulsa 3-4147
David G. Reed

KIDD WILLIAMS DRILLING COMPANY .... Kennedy Bldg., Tulsa 54-5256
Oscar Hatcher

LAHMEYER GEOPHYSICAL LAB ....1136 E. 37th, Tulsa 7-7253
John D. Lahmeyer

LORAC SERVICE CORP. ... Kennedy Bldg., Tulsa 2-8181
Robert S. Finn

MANHART, MILLISON & BEEBE .... Jenkins Bldg., Tulsa 54-5281
Albert L. Ballou, Jr. | Carl W. Blakey | T. A. Manhart
Chet H. Jameson, Jr. | Edgar R. Locke | John J. Rupnik

MAYES-BEVAN COMPANY .... Kennedy Bldg. 2-9574
Karl W. Abel | Tom D. Mayes

MID-CONTINENT PETROLEUM CORPORATION
Mid-Continent Bldg., Tulsa 3-3101
John Bensko, Jr.

MIDWESTERN GEOPHYSICAL LABORATORY .. 3400 S. Harvard, Tulsa 7-7521
Raymond D. Atchley | F. J. Handley | G. Robert Morrow
Raymond G. DeVerse | Wayne E. Harrison | Donald G. O'Brien
Kennith Frakes | Stephen J. Jatras | Edward R. Walker
Robert H. Gish | M. E. Morrow

OHIO OIL COMPANY .... Thompson Bldg. 3-5121
A. C. Austin | F. G. Knight

OKLAHOMA A. & M. COLLEGE .... Stillwater, Okla. 1480
Ray L. Six

OIL & GAS JOURNAL .... 211 S. Cheyenne, Tulsa 3-6291
Philip C. Ingalls | John C. McCaslin

OIL CAPITOL ELECTRONICS CORPORATION .... 923 E. 4th, Tulsa 5-7214
G. C. Green

OIL EXPLORATION, INC. .... Oil Capital Bldg., Tulsa 2-7246
Homar C. Moore | Price E. Roberts

OLIPHANT LABORATORIES, INC. .... Nat'l Bank of Tulsa Bldg., Tulsa 5-7268
Charles W. Oliphant

PETROLEUM CONSULTANTS .... 515 S. Main, Tulsa 4-0144
J. T. Woodburn

PETTY GEOPHYSICAL ENGINEERING CO .... Hunt Bldg., Tulsa 3-1382
W. Lee Moore | Leland Snow

PHILLIPS PETROLEUM COMPANY .... Phillips Bldg., Bartlesville 6600
Ronald E. Beck | Clifford E. Hallock, Jr. | W. F. Moore, Jr.
J. E. Bondurant | Ernest W. Heyl | Floyd H. Morris
William H. Courtier | A. J. Hintze | Raymond G. Piety
Carl C. Crenshaw | J. Rudolph Johnson | R. B. Rice
S. D. Elliott | Perry M. McNally | Bruce F. Wiley
John O. Erickson | H. L. Mendenhall | Earl M. Wolters
Floyd F. Farley

PRECISION EXPLORATION COMPANY .... 910 S. Boston, Tulsa 5-8255
Robert G. Mills | K. A. Robertson

PURE OIL COMPANY .... 118 W. 6th St., Tulsa 3-9101
Stewart Cronin

REPUBLIC EXPLORATION COMPANY .... 815 S. Boulder, Tulsa 5-5671
Frank E. Brown | H. T. Monhollon | Joseph W. Tedder, Jr.
R. P. Green | Walter O. Novelly | Thomas H. Williams, III

SEISDRILL INC. .... 515 Thompson Bldg., Tulsa 2-3149, 2-3140
C. R. Humphrey

SEISMIC INC. .... 4107-A E. 11th, Tulsa 6-7047
Richard Williams

SEISMOGRAPH SERVICE CORPORATION .... Kennedy Bldg., Tulsa 2-8181
H. H. Andrews | James E. Hawkins | S. Wm. Schoellhorn
Robert W. Baltosser | W. O. Heap | A. Leon Spangler
A. J. Barthelmes | A. Maxwell House | Robert W. Teipel
J. R. Blaisdell | Judson G. Jackson | H. M. Thralls
H. R. Breck | Douglas J. Kartman | W. H. Van Horn
Charles L. Bury | R. W. Koeppel | D. F. Warner
Edward J. Crossland | R. W. Mossman | Donald Warnken
Paul M. Ferguson | Richard A. Pohly | G. H. Westby
R. K. Finley | Melvin E. Putnam | James A. Westphal
F. I. Garratte | Van Roberts | Stanley W. Wilcox
J. W. Hammond | Robert W. Saubert | James N. Wilson

SHELL OIL COMPANY .... Mayo Bldg., Tulsa 3-7101

R. F. Christy
R. C. Kendall
C. C. Ludwick
Robert D. Miller

SINCLAIR OIL & GAS COMPANY .... Sinclair Bldg., Tulsa 2-0101

Research Laboratories Inc. .... 860 N. Lewis 2-0101

D. C. Bowman
J. A. Coffeen
John B. Etnyre
R. L. Frossard
Frank R. Kittredge
V. A. Peterson
W. J. Robinson
Jerry E. Upp
John E. Ward

SINCLAIR RESEARCH LABS INC. .... 860 N. Lewis, Tulsa 2-0101

James F. Johnson
H. Joe Jones
Harry L. Pelzer
Charles W. Shannon

SKELLY OIL COMPANY .... Skelly Bldg., Tulsa 2-2131

W. B. Brinnon
Everette H. Clark
William M. Erdahl

SOCIETY OF EXPLORATION GEOPHYSICISTS .... 1138 E. 37th,
(S. E. G.) Tulsa 7-1061

Colin C. Campbell

STANOLIND OIL & GAS COMPANY .... Stanolind Bldg., Tulsa 2-3211

C. E. Buffum
R. Clare Coffin
E. H. Cooley
Jack R. Cooper
Ralph L. Cordell
Karl Dyk
Joseph D. Eisler
Julian F. Evans
Louis P. Goetz
M. S. Graham
Charles F. Hadley
Ralph E. Hartline
R. B. Hollingsworth
John J. Kenton
W. W. Lamkin
Harold M. Lang
Charles C. Lash
J. Austin Lawless
Ruth Rice Leas
L. B. McManis
Samuel T. Martner
James W. Miller
Harriet H. Monroe
Madeline Moote
George R. Newton
Newell Pottorf
A. C. Reid
Daniel Silverman
J. E. Skinner
Neil R. Sparks
T. V. Stephens
Thomas C. Stotler
Edward B. Stover
Garvin L. Taylor
R. A. Weingartner
M. B. Widess
Ray Zongker

STUDENT

Delbert E. Thomas

SUB-SURFACE SEISMOGRAPH CORP. .... Box 5142, Tulsa 72-4405

Richard E. Smyth

SUNRAY OIL CORPORATION .... First Nat'l Bldg., Tulsa 5-6571

Charles P. Bowditch
T. S. Green
T. J. Thomas
Stefan Von Croy
W. Day Waldrep

THE TEXAS COMPANY .... Philtower Bldg., Tulsa 3-4101

F. R. Coryn
Norman J. Lea

TULSA EXPLORATION COMPANY .... Oil Capitol Bldg., Tulsa 2-7479

J. P. Garner

UNIVERSITY OF TULSA .... 600 S. College, Tulsa 9-6351

R. L. Mathieson

WELL SURVEYS INC. .... 624 E. 4th, Tulsa 2-2271

Gilbert Swift


KRAFTBILT all steel Cabinets are
BUILT TO LAST
a lifetime!
Kraftbilt cabinets are designed to HOLD more—yet occupy less space. One compact Rollfile section stores 112 rolled maps; one Log Cabinet takes 7500 well logs! The various needs of geologists are met by cabinets of several sizes and designs. Illustrated Bulletin 352-B gives full details.
For top efficiency, use Kraftbilt Map Weights and All-Plastic Snap-on Map Sticks. Send for details.
8 out of 10 GEOLOGISTS PREFER KRAFTBILT!
E-28 Electric Log Cabinets, holds 4,800 reduced logs.
G-34, G-36 Log Cabinets file 7,500 strip logs.
V-56 Vertical Rollfile, with lock. 56 maps.
Ross-Martin Company
BOX 800-P • TULSA 1, OKLA.

USE ATLAS SEISMIC PRODUCTS

for greater safety and dependability

STATICMASTER® CAPS . . . one of the newest Atlas products for seismic shooting to reduce the danger of premature firing from static electricity.

GIANT® BOOSTERS are designed for use with Staticmaster caps. They assist detonation under high heads of water and are especially suitable for sleeper work.

ATLAS PETROGEL® NO. 1 HV . . . a 60% straight gelatin, formulated for severe pressure conditions and deep hole work.

GIANT PETROGEL 60% HV . . . for firing soon after loading and for shallow hole work where water conditions are moderate.

PETRONITE . . . a new blasting agent developed especially for off-shore work. It is packed in rigid containers and cannot be detonated without a booster.

TWISTITE® assemblies provide a fast means of assembling rigid columns for rapid loading and uniform shooting. They are supplied for all Atlas seismic explosives.

You can depend on your Atlas Distributor for prompt service on all Atlas seismic products. For more data on Atlas explosives, send for your free copy of, "Explosives for Seismograph Prospecting."

ATLAS EXPLOSIVES

"Everything for Blasting"

ATLAS POWDER COMPANY, WILMINGTON 99, DELAWARE

Offices in principal cities